HEALTH EXPECTANCIES AND BURDEN OF DISEASE IN SIX LARGE STATES OF INDIA

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DOCTOR OF PHILOSOPHY

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DECLARATION

I do hereby declare that the thesis entitled "**HEALTH EXPECTANCIES AND BURDEN OF DISEASE IN SIX LARGE STATES OF INDIA**" submitted by me to the School of Social Sciences, Jawaharlal University, New Delhi for the award of the degree of **DOCTOR OF PHILOSOPHY** is my bona fide research work and that it has not been submitted so far in part or in full, for the award of any other degree or diploma of this university or any other university.

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Dedicated

to

Prof. P. M. Kulkarni

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ABBRIVIATIONS

CSDH	Commission on Social Determinants of Health
SMPH	Summary Measures of Population Health
HE	Health Expectancy
HG	Health gap
DFLE	Disability-Free Life Expectancy
ALE	Active Life Expectancy
HALE	Health-Adjusted Life Expectancy
DALY	Disability-Adjusted Life Year
HUI	Health Utilities Index
SES	Socioeconomic status
QALE	Quality-Adjusted Life Expectancy
QALY	Quality-Adjusted Life Years
ELWD	Expectation of Life without Disability
REVES	Réseau Espérance de Vie en Santé
OECD	Organisation of Economic Co-operation and Development
HLY	Healthy Life Years
EU	European Union
EU-SILC	European Union Statistics on Income and Living Conditions
EUROSTAT	European Statistical Office
NCHS	National Centre for Health Statistics
SSA	Social Security Administration
HALS	Health and Activity Limitations Survey
HLE	Healthy Life Expectancy
ONS	Office for National Statistics
ADL	Activities of Daily Living
SRS	Sample Registration System
NSS	National Sample Survey
MFLE	Morbidity-Free Life Expectancy
SAGE	Study on Global Ageing and Adult Health
SABE	Health, Well-being and Ageing
WHS	World Health Survey
GBD	Global Burden of Disease
YLL	Years of Life Lost due to Premature Mortality
YLD	Years Lost due to Disability
DALE	Disability-Adjusted Life Expectancy
LGA	Local Government Areas
EME	Established Market Economies
NCDs	Non-communicable diseases

CMNN	Communicable, Maternal, Neonatal and Nutritional
IHD	Ischaemic Heart Disease
COPD	Chronic Obstructive Pulmonary Disorder
MCCD	Medically Certified Causes of Death
ICMR	Indian Council of Medical Research
DISMOD	Disease Modelling
HRQL	Health-Related Quality of Life
HUI3	Health Utilities Index Mark 3
ART	Acute Respiratory Tract infection
TB	Tuberculosis
BP	Blood pressure
STD	Sexually Transmitted Disease
TLE	Temporary Life Expectancy
NFHS	National Family Health Survey
NSSO	National Sample Survey Organization
IIPS	Institute for Population Sciences
PYLL	Potential Years of Life Lost
SEYLL	Standard Expected Years of Life Lost
GBDS	Global Burden of Disease Study
ADW	Average Disability Weight
MI	Myocardial Infarction
LRI	Lower Respiratory tract Infection
URI	Upper Respiratory tract Infection
DW	Disability Weight
OA	Osteoarthritis
RA	Rheumatoid Arthritis
ASDR	Age-Specific Death Rate
SLE	Standard Life Expectancy
AFLE	Ailment-Free Life Expectancy
ASPR	Age-Specific Poor Health
SF 36	Short Form 36
Euroqol 5D	European Quality of Life
SC	Scheduled Castes
ST	Scheduled Tribe
SBM	Swachh Bharat Mission
SPM	Suspended Particulate Matter
BPL	Below Poverty Line
PMUY	Pradhan Mantri Ujjwala Yojana
LPG	Liquefied Petroleum Gas
GDP	Gross Domestic Product

Chapter 1
Introduction

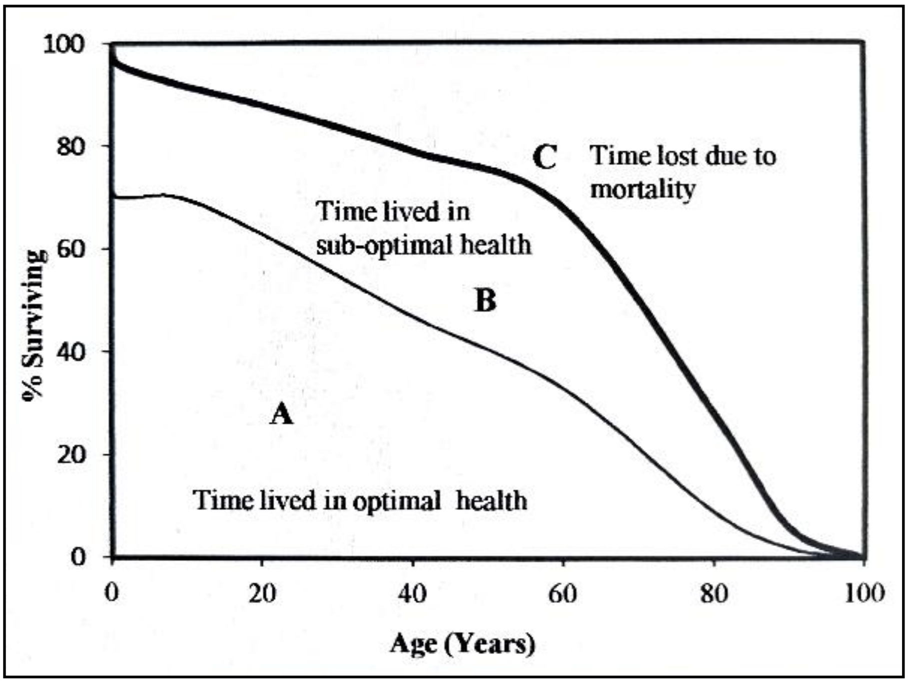
1.1. Introduction

According to the Commission on Social Determinants of Health (CSDH), the level of development of any society "can be judged by the quality of its population's health, how fairly health is distributed across the social spectrum, and the degree of protection provided from disadvantage as a result of ill-health" (Commission on Social Determinants of Health, 2008, Para. 3). The fundamental requirement for this kind of analysis is the empirical statistics on the health status of the population. Such information is also necessary for policymaking in the field of public health (Melse et al., 2000). Conventionally, we use the statistics on mortality and data on the incidence and prevalence of diseases to understand the health conditions of the people (Murray, 1994). Infant Mortality Rate, Under-five Mortality Rate and Maternal Mortality Ratio are common indicators used to assess the health status. However, these indicators measure the negative aspects of health. In the light of promoting good health, life expectancy at birth is considered a positive measure of health. Since it is not dependent on the population's age structure, it has long been used to analyse the change in the health state of a population and compare the health status between populations.

In the 20th century, a continuous decline in death rates in industrial countries called for a serious re-examination of how we should measure health. "Because of the non-linear relationship between age-specific mortality and the life expectancy index, significant declines in death rates at older ages have produced only relatively modest increases in life expectancy at birth" (Murray et al., 2002, p. xiii). Besides, the countries with low death rates observed that the increase in the length of life was primarily caused by the mortality reductions from chronic illness at older ages. Therefore, serious debate cropped up "as to whether longer life means better health for the surviving population" (Nusselder, 2003, p. 35). Public health researchers and policymakers became more serious about the impact of chronic diseases as their consequences include not only death but also lower productivity, prolonged disability and need for care (Sullivan, 1966). They emphasised that morbidity conditions should be adequately reflected in health policy and setting priorities. These considerations led to the development of "Summary Measures of Population Health (SMPH) that combines both mortality and morbidity data to represent overall population health as a single number" (Field and Gold, 1998, p. 4).

In the last fifty years, numerous researchers have contributed to the formulation, calculation and use of SMPH. Broadly, SMPH can be grouped into two families based on a simple survivorship curve – (1) Health Expectancy and (2) Health Gap. In Fig. 1.1, the bold curve is the survivorship curve for a hypothetical population. The lower slender curve is an imaginary curve of the survivors at each age x in full health. Area A shows time lived in optimal health; area B represents time lived in suboptimal health, and area C indicates time lost due to mortality. Area A+B under the bold survivorship curve represents life expectancy at birth. Here, health expectancy (HE) is expressed as HE = A + f(B), and f( ) is a function assigning weights to health states lived during time B where optimal health weights 1. The health gap (HG) is shown as HG = C + g(B), where g( ) is a function that assigns weights to time lived in suboptimal health, but where the weight of 1 represents the time lived in a health state equivalent to death.

Fig. 1.1: The survivorship curve



Source: "A Critical Examinations of Summary Measures of Population Health" (Murray, Salomon and Mathers, 2002, p. 19)

Health expectancy is a generic term for those population health indicators "that estimate the average time (in years) that a person could expect to live in a defined health state" (Mathers et al., 2001, p. 6). Examples of health expectancies are Disability-Free Life Expectancy (DFLE), Active Life Expectancy (ALE), Health-Adjusted Life Expectancy (HALE) etc. On the other hand, the health gap measures "the difference between the actual health of a population and some stated norm or goal for population health" (Murray, Salomon and Mathers, 2002, p. 17). An example of a health gap is Disability-Adjusted Life Year (DALY).

There are four types of issues traversing all SMPH:

(1) Technical issues of calculation: Health expectancies may be estimated for a period or a cohort. A critical feature of the health gap is choosing a health target. Both HE and HG can be calculated on the basis of the incidence or prevalence rates of morbidity.

(2) The definition and measure of health state: For determining health expectancies, health states have been defined in various ways ranging from single dimensions of health, for example, disease, disability, impairment to "multidimensional health state descriptions such as the Health Utilities Index (HUI)" (Mathers, 2002, p. 186). Substantial deviations can be observed between actual performances and the self-reported health domain.

(3) Valuation of health states: Computation of health expectancies and health gaps need the value of time spent in each health state relative to optimal health and death as the case may be. For some measures, dichotomous weights are used, and continuous weights are employed for others. For example, in the case of disability-free life expectancy, we put the weight of 1 to the health state without any disability. A weight of 0 is used to conditions of health with any level of disability above a fixed threshold. On the other hand, health-adjusted life expectancies are estimated for a wide range of health states using continuous valuation. HALE gives "a weight of 1 to years of good health, and non-zero weights to at least some other states of less than good health" (Mathers, 2002, p. 181). When continuous valuations are followed, controversy arises regarding whose values are to be used (e.g., health care professionals, patients in a particular health state, general public etc.) and what valuation method should be selected (e.g., visual analogue rating scale, time trade-off, standard gamble, and person trade-off).

(4) Inclusion of other social values: Besides health state valuations, different social preference weights (e.g., age weights and discount rates for future health) can be used in summary measures.

A considerable number of studies are found incorporating debates and discussions about the issues mentioned above (Murray, 1994; Anand and Hanson, 1997; Richardson, 2002; Dachs, 2002; Mooney, 2002; Reidpath et al., 2003; Barendregt, 2003; Kamm, 2006; Sen, 2006). Nevertheless, various SMPH is increasingly being used to serve the following purposes (Bone et al., 1994; Murray et al., 2002):

(1) To compare the health of the population from one region to another region. Such comparisons are crucial to determine the success of different health systems.

(2) To monitor changes in the health of a given population for assessing the results of intervention strategies taken for the improvement of health.

(3) To identify and measure inequalities in health within the population of a particular region.

(4) To offer better recognition of the consequences of morbidity on overall population health.

(5) To predict health service needs.

In the light of the effectiveness of SMPH and its use throughout the world to assess population health, one can be curious to know the health status of the population of India based on various summary measures of population health.

As health has both intrinsic and instrumental values, i.e., it directly influences a person’s well-being and preconditions to her functioning as an agent, inequality in health has gained special attention from policymakers in the last few decades. The present apprehension with health inequality highlights that “health is influenced by a wide range of social circumstances and public policies, not just by access to health care” (Anand and Peter, 2006, p. 2). Concern about the differences in health status among socioeconomic groups in the same country emerged as a dominant notion in the international health arena during the 1970s, which was the decade of radical thinking in the academic field of various subjects. In 1978, the famous Alma-Ata declaration announced ‘Health for All’ by 2000 as the major social goal of all governments (World Health Organization & United Nations Children's Fund, 1978). The Alma-Ata declaration emphasised primary health care under which inexpensive services to be provided through the government-supported health care system in the rural areas to offer health benefits to the poorer section. By mid-1980, attention shifted from ‘Health for All’ to ‘health sector reform’. In the mid-1990s, focus again swung back to the distributional dimension of health, as evidenced in the World Health Report 1995 (Gwatkin, 2004).

Still, after thirty years of Alma-Ata declaration, the Commission on Social Determinants of Health observed that “Our children have dramatically different life chances depending on where they were born. In Japan or Sweden they can expect to live more than 80 years... and in one of several African countries, fewer than 50 years. And within countries, the differences in life chances are dramatic... In countries at all levels of income, health and illness follow a social gradient: the lower the socioeconomic position, the worse the health”

(CSDH, 2008, A new global agenda for health equity, Para. 1). There is consistent evidence throughout the world that people with higher socioeconomic status (SES) have better health than the people with lower SES (Marmot, Shipley and Rose, 1984; Wagstaff, Pact and Doorslaer, 1991; Feinstein, 1993; Mackenbach et al., 1997; Lasser, Himmelstein and Woolhandler, 2006; Huguet, Kaplan and Feeny, 2008; Menvielle et al., 2010; Hosseinpoor et al., 2012; Elgar et al., 2015). Therefore, from the public health perspective, the formulation of policies and programmes to reduce health inequality has received particular importance.

Public health research on health equity follows two approaches – direct and indirect. In a direct approach, healthy inequality emerges if people's health state differs from an ideal situation. In this case, the interconnections and influences of various social spheres on health outcomes are not considered. However, many believe that inequalities in health are unfair because they are the products of unjust socio-political and economic structures. This approach focuses on the underlying social processes of health inequality and is known as the indirect approach to health equity. One aspect of this approach is that "it provides a basis for choosing relevant social groups in the assessment and explanation of social inequalities in health" (Peter, 2006, p. 99). According to Anand (2006), the studies on health inequality among different groups facilitate identifying high-risk groups or groups in feeble health. "A reduction in the burden of health problems in disadvantaged groups offers great potential for improving the average health status of the population as a whole" (Mackenbach et al., 1997, p. 757). In this context, it is imperative to examine how health is distributed across the socioeconomic spectrum in India so that we can identify the disadvantaged sections in the society and appropriate policies can be conceived to improve their health and well-being.

1.2. Review of Literature

In the last three decades, population health study is increasingly gaining importance as a field of study. We may define population health as the health outcomes of a population assessed by health status indicators, distribution of such outcomes within the population and the impact of various determinants of health (such as physical environment, socioeconomic conditions, biological factors, the efficiency of health care services etc.) on the appropriate outcome (Kindig and Stoddart, 2003). There is an increasing trend of showing health outcomes of the population using SMPH. According to Kindig (2007), health outcomes often include increasing overall health and reducing inequalities across subpopulations.

1.2.1. Summary measures of population health: Health expectancies and health gaps

There are various summary measures of population health. This section will present a review of the literature to understand the trends and gender differences in health expectancies and health gaps.

(a) Health expectancies in the developed world: Trends and the gender gap

In 1964 Sanders first combined the data on mortality and morbidity to understand the levels of health for various communities (Sanders, 1964). Based on the Kit Carson County Morbidity Study conducted in America, Sander depicted that improving health services would facilitate an early diagnosis of chronic diseases that may help to increase life expectancy. Consequently, communities having sufficient health care would register a greater prevalence of chronic diseases and lower death rates than communities with inadequate health care. To evaluate the efficiency of health services in various communities, he developed a modified life table method based on (a) death rates and (b) functional effectiveness (as a substitute for morbidity). He then estimated productive man-years for each cohort of conceptions. A higher number of productive man-years per 100,000 conceptions indicated better health care services.

The following year, Chiang developed mathematical models for describing the state of health of a given population in a given period of time (Chiang, 1965). Chiang tried to develop general models to measure the frequency of illness, duration of disease and time lost due to death. Combining these three variables, he computed the average fraction of the year in which an individual remained healthy. He referred to that fraction as the mean duration of health, which was used as an index of the health of a population.

Sullivan developed the first simple and precise method of calculating health expectancy in 1971. Based on the National Health Interview Survey of the USA (published by National Centre for Health Statistics, 1964) and the Vital Statistics of the USA of 1965, he estimated the life expectancy free of disability and free of bed-disability for White and all other persons by sex of the mid-1960s (Sullivan, 1971). To calculate life expectancy and DFLE, he used period life tables where the variables were age-specific death and disability rates of a particular time. He found that disability-free life expectancy (DFLE) at birth was 61.6 years and 68.4 years for males and females, respectively. Bed-disability free life expectancy was 65.2 years for males and 71.4 years for females. The gender gap in both cases was slightly low at the age of 65 years.

In 1979, Mckinlay and Mckinlay presented a paper on the health trends of Americans from 1964 to 1974 (McKinlay & McKinlay, 1979). They also published an article on this topic with Beaglehole in 1989. Their estimation of the disability-free probability of life revealed an increase in the Americans' life expectancy over a few decades, but the increase was mostly seen as the years of disability (McKinlay, McKinlay and Beaglehole, 1989).

In Japan, the social indicator movement in the 1960s led to the development of various useful socioeconomic indicators. The Council of National Living tried to integrate many of them and published trial results in 1974 (Mieno, 1977). The results included information on the changes in life expectancy (LE) and DFLE in Japan between 1966 and 1970. It was found that the rise in LE was slightly higher than the rise in DFLE during that period (The Council of National Living, 1974).

Based on available data, researchers started calculating the health expectancies of Canada in the early 1980s. In 1983 Wilkins and Adams published a book named "Healthfulness of Life". The summary of their work was also published as a paper in the "American Journal of Public Health" (1983). Using the information on short-term disability and long-term activity restriction from the Canada Health Survey (1978-79), long-term stay in hospitals from institutional records, and mortality data from vital statistics, they estimated life expectancy (LE) in each health and a sum of these indices was named Quality-Adjusted Life Expectancy (QALE). In this method, expected years of life lived were subdivided into different health states (e.g., life-years lived institutionalised, life-years under restricted activity but not involving institutionalisation, etc.). QALE was estimated by weighing the expected years in each health state and then adding the products. Weights were arbitrary. For example, in long-term institutionalisation, the assigned weight was 0.4; in activities not restricted, the assigned weight was 1.0. The estimated difference between LE and QALE was 5.0 years for males and 6.6 years for females. Wilkins and Adams also calculated life expectancy and DFLE of the Canadians for 1951 and compared the same between 1951 and 1978. They found that LE increased by7.5 years for females and 4.5 years for males between the two time periods. On the other hand, the increase of DFLE was much less – 1.4 years and 1.3 years for females and males, respectively.

In 1986, Gudex of York University estimated Quality-Adjusted Life Years (QALY) in four areas of medical care – treatment in end-stage renal failure, upper limb joint replacement, treatment of cystic fibrosis and surgical treatment of scoliosis. The study aimed to determine the priority in resource allocation, keeping in mind the quality of life, survival, and cost. Information on quality of life was collected from the patients or their relatives/health care workers or published papers. The information included one physical disability (e.g., disability in mobility, housework etc.) and one non-physical condition (e.g., agony, satisfaction with life etc.). The valuation of illness states was based on the response of 70 persons of different backgrounds. Gudex used Classification of the Illness States formulated by Rosser and Kind to estimate the quality of life.

Estimation on disability-free life expectancy for the UK was the first published by Bebbington (1988). He calculated Expectation of Life without Disability (ELWD) for England and Wales for 1976, 1981 and 1985 based on the British General Household survey data. There were two questions in the survey schedule: "(i) Do you have any long-standing illness, disability or infirmity? (ii) Does this illness or disability limit your activities in any way?" (Bebbington, 1988, p. 322). If the answer was 'yes' to both the questions, it confirmed activity limitation due to disability. It was found from the analysis that in 1985 in England and Wales, ELWD was and 61.5 years for females and 58.7 years for males. For the female population, the ELWD increased from 14.4 to 16.2 years between 1976 and 1985. During this period, the ELWD for males improved from 11.8 to 13.1 years. However, the rate of increase in life expectancy was higher than the rate of improvement in ELWD.

One major work on DFLE about the American population was published in 1989 by Crimmins, Saito and Ingegneri. They tried to compare the DFLE of the United States between 1970 and 1980. For mortality data, they used the decennial life tables of the United States. To calculate the percentage of the institutionalised persons, they used census data. Information on disability for the non-institutionalised population was collected from the National Health Interview Survey. Their study revealed that LE at birth rose about three years between 1970 and 1980 for both males and females in the USA. However, in DFLE, the increase was 0.7 years for males; and no change was observed for females. So, they concluded that improvement in medical sciences led to a rise in life expectancy, but people were spending increasing proportions of their lives as bed-ridden dependents.

During the 1970s and 1980s, several studies on disability-free life expectancy pointed to the difficulties of getting comparable data over the long run. The International Network on Health Expectancy and the Disability Process (Réseau Espérance de Vie en Santé, or REVES) was established in 1989 to "conduct research and encourage the use of standardised methods for data collection and calculation of health expectancies" (https://reves.site.ined.fr/en/home/about_reves/). REVES started using DFLE for cross-national comparisons.

“In 1993, Organisation of Economic Co-operation and Development (OECD) included disability-free life expectancy among the health indicators reported in its health database” (Mathers, 2002, p. 178). By the end of the 20th century, a few estimates of DFLE were accessible for 12 OECD countries. In 2011, a health-related report for OECD countries, “Health at a Glance”, provided an estimation of DFLE (referred to as healthy life years in the report) at age 65 for the first time for European countries (OECD, 2011). DFLE/Healthy Life Years (HLY) is estimated using the Sullivan method by Eurostat for European Union (EU) countries annually. For calculating healthy life years, mortality data is obtained from Eurostat's demographic database. Information on self-reported long-term activity limitations from the EU-SILC survey is used to estimate the disability. In 2016, the average HLY at birth was 64.2 years for females and 63.5 years for males in the EU. It corresponded to around 77 per cent and 81 per cent of LE for women and men, respectively (EUROSTAT, 2019).

In the last two decades, plenty of works has been done on DFLE across the world. Some of them are mentioned below.

Crimmins, Hayward and Saito (1994) worked on the change in older Americans' mortality and morbidity rates. They primarily used the Longitudinal Study of Ageing data from 1984 to 1990 and applied the multistate life table model. They concluded that improvement of only mortality or only morbidity led to the rise in the span of dependent life, but if there were a change in both morbidity and mortality, the years of dependent life would remain unchanged. Manton, Gu and Lamb (2006) examined the long-term trends in LE and active life expectancy (ALE) in the USA. They used the data from three sources: (1) “data on Civil War Union Army Veterans conducted by Fogel and Costa”, (2) “the 1982-99 National Long Term Cure Survey” and (3) the “US life tables generated by the National Centre for Health Statistics (NCHS) and SSA” (Manton, Gu and Lamb, 2006, pp. 87-89). Applying the Sullivan method, they calculated LE and ALE of the Americans at age 65 and 85 and found that both life expectancy and ALE increased gradually between 1935 and 1999. The ratio between active life expectancy and life expectancy at age 85 improved from 23.3 per cent in 1935 to 46.9 per cent in 1999.

Another vital research on compression of disability in America was conducted by Cai and Lubtiz (2007). The researchers used the multistate life table method to examine the change in ALE of older Americans between 1992 and 2003 using the Medicare Current Beneficiary Survey data. In their study, an increase in ALE was observed after age 65 between 1992 and 2003. In a paper, Crimmins et al. (2009) analysed the changes in DFLE based on longitudinal data of older Americans collected from 1984 to 2000. This study found that DFLE increased in that period owing to decreased incidence rates of disability and improved rates of recovery from disability. In a recent paper, Crimmins, Zhang and Saito (2016) focused on studying trends in DFLE in the last four decades in the USA. They computed DFLE and disabled LE for 1970, 1980, 1990, 2000 and 2010. Using the Sullivan method, they found that between 1970 and 2010, the rise in DFLE and disabled life expectancy at birth was equal for men. However, women experienced a higher increase in disabled life expectancy than DFLE at birth. On the other hand, between 1970 and 2010, at age 65, the rise in DFLE exceeded the increase in disabled life expectancy for both genders.

Using the Canadian Health and Activity Limitations Survey (HALS) data of 1986 and 1985-1987 life tables for Canada, Carriere and Legare (2000) measured the Healthy Life Expectancy (HLE) of the Canadian people. They computed the disability prevalence rates and the prevalence rates of handicapped (those in need of assistance). It was found that in 1986 in Canada, LE at age 65 was 17.1 years, of which people were expected to live nine years without any disability, 1.6 years in an institution, and 2.9 years with the net handicap. Life expectancy was higher among females than males, but females were likely to spend more years with net handicaps than males.

Burgio, Murianni and Folino-Gallo (2009) calculated DFLE in Italy based on National Health Interview Survey and the European Community Household Panel data using the Sullivan method. They found that both life expectancies and DFLE increased over time. In 2005 life expectancy was higher for females, but DFLE was higher for males.

Based on the data from the Danish Health Interview Surveys, conducted in the years of 1987, 1994, 2000 and 2005, Jeune and Bronnum-Hansen (2008) compared life expectancy in various health states of the Danish population. Sullivan method was used for the study. The authors found that life expectancy without functional limitations and with good self-reported health increased among both genders between 1987 and 2005. They also observed that the percentage of life without mobility restriction increased for males from 72.6 to 83 per cent between 1987 and 2005 at age 65. It rose from 61.1 to 69.2 per cent for females during that period.

Cambois, Blachier and Robine (2013) analysed the trends of DFLE in France between 2003 and 2008. They performed decomposition of DFLE changes and used linear regression to assess the trends. The study found an increase in life expectancy with functional limitation at age 65 during this period. In 2008, females had higher life expectancy than males, but the proportion of DFLE to total life expectancy was higher for the male population.

Since the work of Bebbington (1988), many researchers have estimated DFLE for Great Britain. The Office for National Statistics (ONS) regularly publishes information on the health expectancies of the United Kingdom. From the website of ONS, anyone can download data on DFLE at birth and age 65 by regions of England from 2006-2008. Jagger et al. (2007) estimated the DFLE of the UK based on the interview of the elderly. The interview started in 1991, and follow-up surveys were conducted at 2nd, 6th and 10th years. They observed that DFLE at age 65 was higher among men than women. The study also found that stroke, coronary heart disease, cognitive impairment and diabetes were the significant causes affecting life expectancy. Based on the panel data of the British Household Panel Survey (1991-2004), Khoman, Mitchell and Weale (2008) calculated the healthy life expectancy of Britain from 1992 to 2003 using the probit model to estimate the transition probabilities as a function of initial health state and age. They produced population transition matrices which were adjusted in a statistically coherent way. Applying this method, they found that females' healthy life expectancy merely increased between 1992 and 2003 from 14.2 to 14.3 years. For men, it was 11.4 years in 1992 and 12.3 years in 2003. Recently Guzman-Castillo and colleagues (2017) predicted the trends in LE and DFLE of England and Wales using the IMPACT-Better Ageing Model. According to this study, between 2015 and 2025, life expectancy would increase by 1.7 years, and DFLE would increase by one year. Clark et al. estimated health expectancy for the Scottish population in 2000. Macdonald, Straughn and Sutton (2006) reviewed that work and compared those estimates with the rest of the UK. They found that, in contrast to the other parts of the UK, the health expectancy of Scotland was relatively low, particularly for men.

Perenboom, Oyen and Mutafova (2003) compared various health expectancies (Disability-free Health Expectancy, Disease-free Health Expectancy, Handicap-free Health Expectancy, Perceived Health Expectancy and Mental Health expectancy) of different European countries. In this cumbersome exercise, they discussed the problems of comparability of data. They concluded that harmonisation of methods and instruments were necessary for any comparison. However, they found that, in general, the health expectancies of several East European countries were very poor compared to other parts of Europe. In another study, Jagger and colleagues (2011) also compared various health expectancies among 13 European countries based on the Survey of Health and Retirement in Europe Wave 2 carried out in 2006. They observed that Switzerland achieved the highest health expectancies in all health expectancy measurements, and Poland had the lowest.

Using logistic regression techniques, Heathcote et al. (2003) computed DFLE of older Australians aged above 60. They used data from four population surveys conducted by the Australian Bureau of Statistics in 1981, 1983, 1993 and 1998. They found that the results of 1981 were inconsistent with the results of other years. Females aged 60 were expected to live 50 per cent and 51 per cent of their remaining years in a disabled state in 1988 and 1998, respectively. On the other hand, males aged 60 were expected to live 52 per cent of their remaining lives as disabled in 1988, and it increased to 56 per cent in 1998.

Trends in health expectancies of Australia and New Zealand were examined by Davis, Mathers and Graham (2003). The study was based on surveys specifically designed to assess disability. This type of survey has been conducted in Australia since 1981. In New Zealand, the disability assessment survey started after 1995. However, some information on disability in New Zealand was available from the Social Indicators Survey, 1981 and Household Health Survey, 1991-92. Davis and his colleagues observed that between 1981 and 1998, at age 65, the life expectancy of Australian males improved from 13.9 to 16.1 years, but DFLE decreased from 7.9 to 6.6 years. Female life expectancy at age 65 was 18.1 years in 1981, which rose to 19.8 years in 1998, but DFLE declined by one year during that period. In the case of New Zealand, it was challenging to measure disability trends. However, the authors calculated the DFLE of New Zealand based on the ability to climb stairs. They estimated that between 1981 and 1992, at age 65, DFLE increased for males by 0.1 years but decreased for females by 0.3 years. In 1996-97, DFLE was computed as 7.5 years for men and 9.2 years for women at age 65.

Japan’s Council of National living (1974) estimated the average healthy life expectancy of Japan as early as 1966 (cited in Saito, Qiao and Jitapunkul, 2003). Several other researchers have tried to calculate the DFLE of Japan from time to time. For example, Gunji and Hayashi (1991) estimated disease-free life expectancy between 1974 and 1985 (cited in Saito, Qiao and Jitapunkul, 2003). The authors used the Sullivan method and concluded that the life expectancy of the people of Japan increased in that period. However, disease-free life expectancy declined. Using the double-decrement life table and modified ADL (Activities of Daily Living) measures, Kai et al. (1991) estimated Active Life Expectancy (ALE) in rural districts of Japan. They found that age and joblessness were associated with ADL. Liu and colleagues (1995) analysed the functional state of the elderly (60 years and above) Japanese based on a two-wave National Probability Sample Survey conducted between 1987 and 1990. They applied the multistate life table method to measure

ALE. Their study revealed that in 1989, at age 60, Japanese were likely to live 81 per cent of the rest of their lives in functional independence.

(b) Health expectancies in the developing world: Trends and the gender gap

Health expectancy as an indicator of population health has been used in many developing countries of Asia since the mid-1980s. Using the Sullivan method, Grab et al. (1991), Wang (1993) and Qiao (1997) calculated health expectancies of the people of China (cited in Saito, Qiao and Jitapunkul, 2003). Grab et al. estimated the disability prevalence in China by sex and region based on the National Sampling Survey of Handicapped conducted in 1987. In another study, using the data of the Survey on China's Support Systems for the Elderly (1992), Wang estimated ALE based on four Activities of Daily Living, namely, dressing, toileting, bathing and eating. He observed that among the males at age 60, ALE was 14.9 years in the urban area and 14.8 years in the rural area. For the females, ALE was 16.8 years in rural as well as in urban areas. Qiao compared ALE between 1987 and 1992 for both males and females in China. It showed a sharp rise. Qiao also estimated disease-free life expectancies at different ages for the year 1992. At age 65, disease-free LE was 4.2 and 4.4 years for males and females, respectively.

Gu et al. (2009) studied the changing health expectancies among the elderly in China between 1992 and 2002. They found that life expectancy, ALE and DFLE – all increased in that period for both males and females. When socioeconomic status and health resources were controlled, it was found that improved ADL functioning was significantly affected by disease conditions. Therefore, the authors concluded that the increase in ALE between 1992 and 2002 was associated with a decrease in chronic ailments and other related issues. Liu et al. (2009) examined the trends in DFLE among Chinese elderly using the National Disability Survey data of 1987 and 2006. They found that in 1987, DFLE at age 60 was 13.0 years which increased to 13.9 years in 2006. Using the Sullivan method, Lu et al. (2018) tried to estimate the Morbidity-free Life Expectancy of elderly Chinese. According to their analysis, the average trivial morbidity rate escalated in China from 24.42 per cent to 26.52 per cent between 2000 and 2010. During that period, the moderate morbidity rate decreased from 8.78 per cent to 8.02 per cent, but the severe morbidity rate rose from 0.79 per cent to 1.38 per cent. Recently in an article, Zimmer, Hidajat and Saito (2015) pointed towards compression of morbidity in China. Based on the Chinese Longitudinal Healthy Longevity Study data collected in two periods (2001 to 2005 and 2008 to 2011), they calculated the ratio between the total life expectancy and the DFLE. The ratio increased between the two periods mentioned above, indicating compression of morbidity for both males and females, but the results were statistically significant only for females.

Among other Asian countries, Tu and Chen (1994) calculated the DFLE of the adults in Taiwan for 1986 and 1991 using a double decrement life table model. Data was provided by the Directorate-General of Budget, Accounting and Statistics. According to their analysis in Taiwan in 1986, at the age 65, DFLE was 9.1 years, and disease-free life expectancy was 3.1 years which became 12.9 years and 2.7 years respectively in 1991.

LE and HLE of Thai elderly were calculated by Jitapunkul and Chayovan (2000) for 1986 and 1995. Their work was based on two national surveys of the respective years. Using the Sullivan method, they found that both life expectancies and HLE increased substantially between 1986 and 1995. HLE was lower for men than women, but the proportion of active life to total life expectancy was higher for men. Later Jitapunkal et al. (1999) estimated various kinds of health expectancies of Thailand using National Health Examination Survey II conducted in 1997 (cited by Saito, Qiao and Jitapunkul, 2003). At age 60, ALE for females and males were computed as 21.30 and 18.65 years, respectively. However, the percentage of active life was 91.9 for males and 89.2 for females. DFLE without a short-term disability was 16.66 years and 15.44 years for females and males, respectively, at age 60.

Using the Sullivan method, a study on health expectancies in India was carried out by Thomas, James and Sulaja (2014). They used the information on mortality rates from the Sample Registration System (SRS) and the data on morbidity from the 60th round of the National Sample Survey (NSS). They computed morbidity-free life expectancy, restricted activity-free life expectancy and bed-disability free life expectancy for the elderly. The estimation was given for India and its major states. In 2004 in India, Morbidity-Free Life Expectancy (MFLE) at age 60 was 11.2 years for males and 12.5 years for females. However, the percentages of MFLE to total LE were 67.3 for females and 68.1 for males. The highest MFLE was found in Delhi for both sexes. In India, restricted activity-free life expectancies at age 60 were 14.7 years and 16.5 years for the males and females, respectively. Bed disability-free life expectancy was also higher for females (17.6 years) than males (15.8 years) at age 60. Bora and Saikia (2015) calculated the gender-specific DFLE in India based on self-reported health information. The data used for the study came from WHO Study on Global Ageing and Adult Health (SAGE) in India, 2007. They found a greater prevalence of severe and extreme disability among women in 14 out of 20 ADL measures. The disability-free life expectancy for any number of disabilities was higher among men than women at each age. However, the gender gap in DFLE gradually decreased with increasing age. They also observed that the percentage of DFLE to total life expectancies was higher among men irrespective of their ages.

Sreerupa et al. (2019) compared the life expectancy and mobility-free life expectancy among the elderly in India between the periods 1995-96 and 2004 using the Sample Registration System and National Sample Survey data. Their study indicated the compression of morbidity in India. In another study, based on the data from the Census of India 2011 and the SRS abridged life tables of India 2011, Mishra et al. (2020) computed the DFLE in India. They found higher DFLE among females than males. The study revealed a significant regional disparity in DFLE in India.

In one interesting study, Roberto Ham-Chande (2003) compared health expectancies in urban Latin America and the Caribbean based on the information from Health, Well-being and Ageing (SABE) survey conducted in 2000. He included the following cities in his study: Sao Paulo (Brazil), Montevideo (Uruguay), Santiago (Chile), Buenos Aires (Argentina), Mexico City (Mexico) and Bridgetown (Barbados). At age 65, the highest DFLE was estimated in Montevideo and the lowest in Santiago. Consequently, the highest percentage of DFLE to total life expectancy was also observed in Montevideo (89.9 per cent), followed by Bridgetown (88.6 per cent), Buenos Aires (86.2 per cent), Sao Paulo (85.9 per cent), Mexico City (85.0 per cent) and Santiago (79.3 per cent). Based on the SABE data, Morino et al. (2018) made a detailed study on DFLE among older adults in Santiago, Chile. They used the multistate life table method. The study concluded that LE was higher among the females but compared to the male population, females had a higher percentage of disabled years at older ages.

Romero, Leite and Szwarcwald (2005) estimated healthy life expectancies in Brazil using the data from the World Health Survey (WHS) conducted in 2003. Using the Sullivan method, they calculated HLE at different ages starting from 20 years up to 80 years at an interval of 5 years. They gave four estimates. The first estimate was based on the percentage of the adult who reported good health. The second estimation incorporated the percentage of the people having a long term disease or disability that limited their daily activities. In the third analysis, the rate of unhealthy population was estimated by the average score of functional limitations and based on it, the HLE was calculated. The fourth analysis considered three situations (free of disease/disability, with disease/disability but no activity constraint, and with disease/disability and activity constraint). In this case, weights were put to recognise the severity of different conditions according to age. The highest healthy life expectancy was observed in estimation 1, and the lowest for estimation 2. With increasing age, the disparity in HLE was minimised. However, the percentage of years lived in poor health was higher among the females than males in all estimates.

Studies on the comparison regarding DFLE among developing economies are scarce. One such study was carried out by Santosa et al. (2016). Using the Sullivan method, they calculated the DFLE of six developing economies (China, Ghana, India, Mexico, the Russian Federation, and South Africa) based on the WHO-SAGE data (2007-2010). The lowest prevalence of disability was observed in China and the highest in India. In all six countries, women had higher life expectancies. Still, their percentage of DFLE at age 50 and over was lower than men.

(c) Gender paradox in health expectancies

The studies that have analysed gender gaps in health expectancies mostly pointed out the phenomena called "gender paradox" (Crimmins et al., 2009). What is the gender paradox in health? It indicates that LE and HLE are higher among women than men, but the percentage of healthy life years to total life expectancy at any age is higher among men than women. In the last two sections of our reviewed literature, we have come across several studies that have provided the instances of gender paradox (Romero, Leite and Szwarcwald, 2005; Burgio, Murianni and Folino-Gallo, 2009; Cambois, Blachier and Robine, 2013; Santosa et al., 2016; Morino et al., 2018). We can also mention the studies by Mutafova et al. and colleagues (1997) in Bulgaria, Lai, Lee and Lee (2000) in China, Tsuji et al. (1995), and Konno et al. (2004) in Japan, Jagger and Mathews (2002) in the U.K., Nusselder and Looman in the Netherlands (2004), Reyes-Beaman and colleagues (2005) in Mexico, Bronnum-Hansen (2005) in Denmark, Minicuci and Noale (2005) in Italy, Cheung and Yip (2010) in Hong Kong, Andrade and colleagues (2011) in Brazil, Muangpaisan et al. (2011) and Jiawiwatkul et al. (2012) in Thailand, Tareque, Begum and Saito (2013) in Bangladesh and Thomas, James and Sulaja (2014) in India. All the studies observed the gender paradox in health. However, one study from Brazil by Belon, Lima and Barros (2014) found that at the age 65 years and above, the percentage of healthy life expectancy to total LE was higher among women than men when computed based on self-rated health.

(d) Health gaps as SMPH: Trends and patterns

The most popular measure of health gap called Disability Adjusted Life Years (DALY) was introduced to assess the Global Burden of Disease (GBD) in the "World Development Report 1993" (World Bank, 1993). The rationale for developing DALY as an indicator of the burden of disease has been discussed in detail by Murray and Lopez in their monumental work on the “Global Burden of Disease and Injury Series, Volume I” (Murray and Lopez, 1996). Estimation of DALY combined “the years of life lost due to premature mortality (YLL) in the population and the equivalent ‘healthy’ years lost due to disability (YLD)” (Mathers et al., 2001, p. 9).

The most important findings of the GBD study of the 1990s were published in four consecutive articles in the “Lancet” in 1997 (Murray and Lopez, 1997a; 1997b; 1997c; 1997d). The second article estimated Disability-Free Life Expectancy (DFLE) and Disability-Adjusted Life Expectancy (DALE) for eight world regions. DALE can be defined as “the expectation of the equivalent number of healthy years of life at birth” (Murray and Lopez, 1997b, p.1349). It was found that DALE was the highest in established market economies and the lowest in Sub-Saharan Africa.

The World Health Organization in the year 2000 published the ranking of its member states based on DALE (which was considered an indicator of health system performance of the countries). Next year WHO renamed DALE as Healthy Life Expectancy or Health-Adjusted Life Expectancy (HALE) following the feedback from the member states (Mathers et al., 2001). The “World Health Report 2001” provided an estimation of HALE for 55 countries using an improved methodology, new epidemiological data for some diseases, and comparable data from 63 surveys across the world (World Health Organization, 2001). DALY and HALE are recognised as one of the best measures of health gaps and health expectancies, respectively, and used as essential tools for summarising population health at sub-national, national and world levels.

Several studies presented estimations of DALY and DALE/HALE for different countries/regions of the world. For example, Mathers, Vos and Stevenson (1999) have calculated DALY and DALE for Australia using (a) cohort life expectancies of the Australians for the year 1996 and (b) disability weights of diseases and injuries derived from the GBD study and a Dutch study. They found that among the people 75 years and above, cardiovascular diseases contributed to the highest proportion of YLL, but cancers substituted cardiovascular diseases as the leading cause for people below 75 years. The research also pointed to the increasing prevalence of mental disorders in Australian society. In fact, in 1996, mental disorders were responsible for almost 30 per cent of the morbidity burden of Australia. Another interesting point was that while female life expectancy surpassed male life expectancy by six years, the disability burden expressed by YLD was almost similar for males and females. Two years later, more detailed work on the disease burden was published for the state of Victoria in Australia (Victorian Government Department of Human Sciences, 2005). The researchers identified significant risk factors like smoking and obesity that contributed to the disease burden in that study. Relevant information for this study was collected from 78 Local Government Areas (LGA) in Victoria. The highest YLL was found for cancer (34 per cent of overall YLL), followed by cardiovascular disease (29 per cent). Mental disorders were accountable for the highest share of YLD (26 per cent).

McKenna and his colleagues estimated DALY to identify the most important causes of disability and mortality in the USA. They found that in the mid-1990s, ischaemic heart diseases accounted for the highest number of DALYs lost among both the males and females in the country (McKenna et al., 2005). Another national-level study on DALY was conducted in the Netherlands by the Dutch Burden of Disease Group for 1994. Using national epidemiologic data and Dutch disability weights, DALYs were calculated for 48 diseases. It was found that the three main causes of YLL were ischaemic heart disease, cerebrovascular disease and cancers. On the other hand, mental disorders, alcohol dependence and visual impairments were the leading causes of YLDs (Melse et al., 2000).

DALY was also used at the regional level to examine the health priorities of the people of Geneva. Based on the death rates of the canton of Geneva (1990-94) and YLD data of Established Market Economies (EME), Schopper et al. (2000) estimated that between 1990 and 1994, Geneva lost 235000 DALYs each year. The highest proportion of DALYs lost was due to ischaemic heart disease followed by unipolar major depression, AIDS and alcohol use. Therefore, it is clear that since the first use of DALYs, researchers and policy analysts are conferring immense importance on DALYs to identify health priorities.

At the global level, the estimates of DALYs have been regularly produced by the Global Burden of Disease Study (GBDS). After the early 1990s, DALYs were estimated globally in 1999-2002 and 2004 (Das and Samarasekera, 2012). GBD 2010 added a new crown to the efforts of quantifying the disease burden by analysing 291 diseases and injuries of 21 world regions. The summary of the study was published in several articles in the "Lancet" in 2010. It revealed that between 1990 and 2010, globally, the mortality rate due to communicable, maternal, neonatal and nutritional causes dropped from 34.1 per cent to 24.9 per cent. During this time, the mortality rate due to non-communicable diseases (NCDs) shot up from 55.8 per cent to 65.5 per cent. The proportion of deaths due to injury was 8.8 per cent in 1990, which slightly increased to 9.6 per cent in 2010. Lower respiratory infection and ischaemic heart disease were the leading causes of the YLL in 1990 and 2010, respectively (Lozano et al., 2012). It was found that YLD increased 33.3 per cent between 1990 and 2010.

However, the growth of population accounted for a 30.1 per cent change in the percentage. Non-communicable diseases contributed to 78.6 per cent YLDs in 2010, the leading three causes being mental disorders, musculoskeletal problems and diabetes (Vos et al. 2012). One significant accomplishment of the GBD study of 2010 was identifying the risk factors that contributed to the DALYs. High blood pressure was identified as the most critical risk factor, followed by tobacco smoking (including passive smoking) and alcohol use (Lim et al., 2012). Another aspect of GBDS 2010 was to produce the Health Adjusted Life Expectancy (HALE) of 187 countries and compare the changes of HALE between 1990 and 2010. During this period, male HALE at birth increased from 54.8 years to 59.0 years. On the other hand, female HALE at birth improved from 58.7 years to 63.2 years. In 2010, the highest male and female HALE was recorded in Japan (70.6 years for males and 75.5 years for females). The lowest male and female HALE was observed in Haiti (27.8 years for males and 37.1 years for females). So, in 2010, a considerable disparity in HALE persisted across the world. Not only that, between 1990 and 2010, 22 countries recorded a decline in male HALE, and 11 countries reported a decrease in female HALE (Salomon et al., 2012).

Based on the GBD 2010, Haro et al. (2014) made a comprehensive study of the disease burden in Spain. The authors found that NCDs were responsible for 91.3 per cent of the total deaths in Spain in 2010. The five major causes of loss of DALYs in Spain remained unchanged between 1990 and 2010. These diseases were: neoplasms, cardiovascular and circulatory diseases, musculoskeletal disorders, mental and behavioural disorders and diabetes.

The most recent study on the GBD is available for 2016, where DALYs and HALE have been estimated for 195 countries and territories (GBD 2016 DALYs and HALE Collaborators, 2017). According to this study, 2.39 billion DALYs were lost in 2016. Between 1990 and 2016, the contribution of NCDs to the total number of DALYs lost increased 36.6 per cent, but the contribution of communicable, maternal, neonatal and nutritional (CMNN) diseases decreased 40.1 per cent. In 2016, NCDs accounted for 72.3 per cent of deaths, while CMNN diseases were responsible for 19.3 per cent of fatalities (GBD 2016 Causes of Death Collaborators, 2017). The GBD 2016 Causes of Death Study revealed that between 2006 and 2016, deaths from common infectious diseases recorded a considerable fall. The only exception was Dengue which showed a substantial increase of 81.8 per cent between 2006 and 2016. Among the NCDs, the number of deaths from ischaemic heart disease (IHD) increased from 7.96 million in 2006 to 9.48 million in 2016, i.e., a 19 per cent increase during that period. Globally, IHD accounted for the maximum loss of DALYs in 2016, followed by cerebrovascular disease and lower respiratory infections. A high proportion of IHD, haemorrhagic stroke, chronic obstructive pulmonary disorder (COPD), and lung cancer was attributable to major risk factors (GBD 2016 Risk Factors Collaborators, 2017). High blood sugar, hypertension, smoking, obesity, and poor diet were the major risk factors of ill health. Injuries accounted for 8.43 per cent of all deaths in 2016. Conflict and terrorism were responsible for the highest increase in fatalities from injuries (Lancet editorial, 2017). Although maternal health has not improved much since 1990, a significant decrease in under-five deaths has been noticed between 1970 and 2016 – from 16.4 million to 5 million (GBD 2016 Mortality Collaborators, 2017). At birth, the global HALE was 56.9 years in 1990 and 63.1 years in 2016. Between 1990 and 2016, HALE increased by 6.04 years for men and 6.49 years for women. In 2016 the highest male and female HALE was observed in Singapore (72 years for males and 75.2 years for females). The lowest HALE for the males and females was recorded in Lesotho (41.5 years) and the Central African Republic (45.6 years), respectively (GBD 2016 DALYs and HALE Collaborators, 2017).

Literature on SMPH in terms of health gaps is very few in the context of India. One crucial work in this field was done under Dr B. Shah of the Indian Council of Medical Research (ICMR) (Shah et al., 2004). The study assessed the burden of some selected non-communicable diseases based on the data on Medically Certified Causes of Death (MCCD), Survey of Causes of Death – Rural, and Cancer Registration. It also used the data from published review articles. The whole work was done with the help of the DISMOD software. According to this study, the number of DALYs lost in India due to ischaemic heart disease was 14.3 million and 16 million in 1994 and 2004, respectively. Stroke accounted for the loss of 5.80 million DALYs in 1994 and 6.37 million DALYs in 2004. The loss of DALYs from diabetes increased from 1.99 million in 1994 to 2.26 million in 2004. The study also estimated DALYs lost from various types of cancers and assessed the role of tobacco use and hypertension as risk factors of NCDs. Compared to the WHO estimation, the ICMR estimation of disease burden from cancer was conspicuously lower in India in 2004.

Recently, the India State-level Disease Burden Collaborators took an enormous effort to estimate DALY for each state of India. One of their works was published in the "Lancet" in 2017. They found that the age-standardised DALY rate dropped by 36.2 per cent between 1990 and 2016 (India State-level Disease Burden Initiative Collaborators, 2017). However, non-communicable diseases increased at a very high pace during this period. In 2016 in India, 27.5 per cent and 61.8 per cent of deaths were attributed to communicable and non-communicable diseases, respectively. The remaining 10.7 per cent of deaths occurred due to injuries. The study also identified five major diseases causing the loss of DALYs in India in 2016. These were “ischaemic heart disease, chronic obstructive pulmonary disease, diarrhoeal diseases, lower respiratory infections, and cerebrovascular disease; and the five leading risk factors for DALYs in 2016 were child and maternal malnutrition, air pollution, dietary risks, high systolic blood pressure, and high fasting plasma glucose” (India State-level Disease Burden Initiative Collaborators, 2017, p. 1).

Another study by Menon et al. (2019) estimated the disease burden in India in 2017 using the data from 2017 UN death totals, Sample Registration System for 2010-17, Million Death Study for 2010-14, and YLD-YLL ratios from WHO Global Health Estimates. Their analysis showed that in 2017, 486 million DALYs were lost in India. They found that for perinatal and nutritional conditions, chronic respiratory diseases and diarrhoea, DALY rates were twice in rural areas than urban areas. In contrast, DALY rates of ischaemic heart disease were conspicuously higher in urban areas. A recent article assessed disease burden due to child and maternal malnutrition in India (India State-level Disease Burden Initiative Malnutrition Collaborators, 2019). According to this study, malnutrition accounted for 68.2 per cent of the total under-five mortality and 17.3 per cent of all age DALYs in India in 2017. The DALY rate attributable to malnutrition among children was very high in Uttar Pradesh, Bihar, Assam and Rajasthan.

1.2.2. Socioeconomic inequalities in health as revealed by summary measures of population health

Inequality in health based on socioeconomic status is not a new phenomenon, and in the last two centuries, numerous researchers have established this fact on firm ground. From earlier, writers and painters propounded that all are equal before death. Still, this concept is far from the truth, as mortality during epidemics and famine was much higher among the impoverished than the affluent (Mackenbach, 1995). In the nineteenth century, the works of Villerme (France), Virchow (Germany) and Chadwick (England) threw light on socioeconomic inequality in health (Mackenbach, 2002). Two classic pieces of the last fifty years on socioeconomic inequality on mortality must be named here: “Differential Mortality in the United States” by Kitagawa and Hauser (1973) and “Inequalities in Health” (popularly known as the “Black Report”, 1988) by Townsend, Davidson and Whitehead of United Kingdom (Cited in Feinstein, 1993). Now we have vast literature showing that mortality and morbidity are lower among higher socioeconomic groups. However, here we have reviewed the works that dealt with socioeconomic inequalities as revealed by SMPH. It is important to reiterate that there are numerous works on socioeconomic inequality in mortality and other health aspects, like disease, immunisation, institutional delivery, ante-natal care etc., but we will review those studies that have analysed health inequality using such indicators that combine both mortality and morbidity. When mortality and morbidity are combined, they present larger inequalities "because people in lower socioeconomic groups do not only live shorter lives but also spend a larger proportion of their life in ill-health" (Mackenbach, 2002; p. 1777).

(a) Findings on health inequality based on race and education

Let us begin with the work of Sullivan (1971), who, for the first time, introduced the concept of disability-free life expectancy (DFLE). He observed that in the mid-1960s, the DFLE at birth was 7.4 years higher for White males than non-White males in the USA. The gap in DFLE at birth between White and non-White females was eight years in favour of White females. At age 65, DFLE was 9.5 years for White males and 7.5 years for non-White males. White females had 2.1 years higher DFLE than non-White females at age 65. The same trend was also found in bed-disability-free life expectancy, i.e., White males and females showed better health status than non-White males and females. The study indicates social inequality in health between the White and the non-White population in America.

Changes in the DFLE between 1970 and 1980 for both Black and White Americans were estimated by Crimmins, Saito and Ingegneri (1989). They found that male DFLE at birth increased by 0.6 years for Whites and 0.5 years for Blacks in that decade. Life expectancies at birth free of bed-disability increased by 2.7 years and 3.7 years for the Whites and the Blacks, respectively. However, the scenario changed for the very old population. While male DFLE at age 85 remained unchanged for the Whites between 1970 and 1980, it reduced to 0.1 years for the Blacks. Also, the male life expectancy, free of bed-disability, at age 85 rose 0.3 years for the Whites, but it went down 0.2 years for the Blacks. Among the females, between 1970 and 1980, an adverse change in DFLE at birth was found for the Whites (-0.2 years), but a positive change was observed for the Blacks (1.1 years). The situation reversed at the age of 85. In the above mentioned period, DFLE at age 85 increased 0.3 years for White females but reduced 0.1 years for Black females.

Another study on active life expectancy among elderly Blacks and Whites by educational status was conducted in the Piedmont region of North Carolina by Guralink et al. (1993). In that research, a lower level of education was defined as less than 12 years of completed schooling and a higher level as 12 or more years of completed schooling. The study found that “there were no large differences between Blacks and Whites in LE and ALE when education was taken into account” (Guralink et al., 1993, p. 112). Crimmins and Saito (2001) conducted a similar type of research and tried to examine the HLE of Whites and African-Americans by education and gender for the years 1970, 1980 and 1990. They found that significant differences in HLE existed between the two racial groups at the lower level of education. According to them, both mortality and morbidity were higher among the people with a lower level of education. Between 1980 and 1990, morbidity declined among the more educated group but increased among those with lower educational status.

Based on the 5% Public Use Microdata Survey 1990, Hayward and Heron (1999) investigated racial inequality in ALE/DFLE among adult Americans. They divided the population into five racial groups: Whites, Blacks, Asian-Americans, Native Americans, and Hispanics. According to the study, the highest life expectancy and DFLE were found among Asian-Americans. Comparatively lower life expectancy was observed among the Blacks and the Hispanic population. The Blacks and the Native Americans showed a higher percentage of time lived in disability at various stages of life.

Shreds of evidence of racial inequality in Tennessee, USA, were observed by Chang, Nocetti and Rubin (2005). The authors calculated Healthy Life Years (HLY) for major racial groups by gender for 2001. At age one year, the highest HLY was found among White females (63.6 years) and the lowest among the Black males (55.1years). Estimated HLY for Black females and White males was 60.2 years and 59.5 years, respectively.

To assess the disease burden in the USA, McKenna et al. (2005) used DALY as a summary measure. They tried to find out the most important causes for the loss of DALYs by gender and ethnicity in 1996. They observed that the top three causes for the loss of DALYs among the White males were ischaemic heart disease (IHD), road traffic injuries, and lung cancer; among the Black males, the leading three causes were HIV/AIDS, violence and homicide, and IHD; among the Asian males, these were IHD, unipolar major depression, and road traffic injuries. Among females, IHD was responsible for the maximum number of DALYs lost among both the Whites and the Blacks. Unipolar major depression was the principal cause of DALYs lost among the females of Asian origin. Among the Native Americans, the highest burden of diseases was attributed to alcohol use, irrespective of gender.

The positive impact of education on health expectancies has been revealed by many studies (Freedman and Martin, 1999; Bossuyt et al., 2004; Hidajat, Hayward and Saito, 2007;

Camargos, Machado and Rodrigues, 2007; Huguet, Kaplan and Feeny, 2008; Majer et al., 2010). Using the Survey of Income and Program participation data, Freedman and Martin (1999) observed that education contributed to enhancing the functional health of elder Americans between 1984 and 1993. Bossuyt et al. (2004) analysed the role of education in improving health expectancies in Belgium. For the construction of life tables, they used data from the 1991 census and the National Population Register. To calculate health expectancy, they used information on perceived health status from National Health Interview Survey 1997. Based on the highest level of educational attainment, they selected ten different categories reflecting socioeconomic hierarchy. The maximum differences in life expectancies and health expectancies among various educational groups of males at age 25 were 5.5 and 17.8 years, respectively. For females, the maximum difference in life expectancy and health expectancy among different educational groups was 3.5 and 24.7 years, respectively. Therefore, based on educational attainment, inequality in health expectancy was higher among females than males. Analysing the European Community Household Panel data of seven annual waves (1995-2001), Majer et al. (2010) tried to quantify socioeconomic disparity in DFLE at the age of retirement in ten Western-European countries. Among the males and females, the differences in DFLE between high and low educated groups were 4.6 years and 4.4 years, respectively. All the countries presented a similar pattern.

Crimmins and Cambois presented an outstanding research paper on socioeconomic differences in health in 2003 in the book "Determining Health Expectancies". They reviewed nineteen studies conducted between 1980 and 2001 at different parts of the developed world to examine how health expectancies varied among different socioeconomic groups. Among the studies, seven were from the United States, two each from Canada, Finland and the Netherlands, and one each from Austria, Belgium, France, Great Britain, Norway, and Sweden. The Majority of the studies used education as an indicator of socioeconomic differences. However, income, occupation and race were also used as proxy indicators of socioeconomic groups. Most studies used the Sullivan method to determine health expectancies, but three were based on multistate/double decrement life tables. After reviewing the papers, Crimmins and Cambois (2003) concluded that the differences in health expectancies among socioeconomic groups were higher than the life expectancies. Also, the higher the socioeconomic disparity in LE, the greater was the socioeconomic inequality in HLE.

In the developing world, several researchers have tried to examine health inequality by SES using SMPH. Hidajat, Hayward and Saito (2007) studied the impact of education on

ALE in Indonesia. Using the Indonesian Family life Survey of 1993 and 1997, they calculated active life expectancy by education. They observed that education reduced mortality risk, but it had no impact on ALE. Camargos, Machado and Rodrigues (2007), in another study, observed that in 2000, DFLE among the elderly in Sao Paulo improved with increasing level of education irrespective of gender.

(b) Findings on health inequality based on occupation, income and place of residence

Various researches concluded that differences in occupation and level of income are responsible for health inequality among social groups. In England, Melzer et al. (2000) examined the relationship between socioeconomic status (SES) and DFLE among older people during 1987-91. They categorised social class as Class I to Class V. Class I and II comprised professional and managerial occupations. Class III to V included skilled non-manual (e.g. clerical), partly skilled and unskilled occupations. They found that in the age group 65-69, men in social class III to V were likely to survive 11.6 years without disability and 1.6 years with a disability. In comparison, the estimates for men in social classes I and II were 14 years and one year, respectively. According to this study, the DFLE and LE with disability of the women in social class I and II in the age group 65-69 were 15.5 years and 3.2 years, respectively. For women in the same age group in social class III to V, DFLE was estimated at 13.8 years, and disabled life expectancy at 3.4 years. Therefore, the DFLE was higher among relatively privileged socioeconomic groups in England in the late 1980s.

Wilkins and Adams (1983) analysed Canada's quality-adjusted life expectancy (QALE), incorporating demographic, regional, and social dimensions. In the late 1970s, they found that LE at birth was higher among the rich than the poor and the difference in QALE between the richest and the poorest income quintile group was 7.7 years. It indicates that poor people of the Canadian society experienced both shorter life and more disability-related sufferings than the rich.

Huguet, Kaplan and Feeny (2008) tried to assess the impact of income and education on Health-Related Quality of Life (HRQL) on older adults (aged 65 years and above) in America and Canada. The study was based on the Joint Canada/United States Survey of Health conducted in 2002-2003. Using the multidimensional Health Utilities Index Mark 3 (HUI3), they found that when demographic and health-related factors were controlled, lower-income Americans were more likely (Odd Ratio 1.62, $p<0.05$) to report moderate/severe disability than middle/higher income group. Also, in America, people with lower education reported a higher rate of moderate/severe disability than people with a higher level of education. However, no significant association was found between HRQL and income/education in Canada.

Mathers, Vos and Stevenson (1999) analysed the socioeconomic disadvantage of disease burden in Australia in 1996. They found that the burden of disease increased with socioeconomic disadvantage. Compared to the top quintile, DALY per 1000 in the bottom quintile was 37 per cent higher for men and 27 per cent higher for women.

Kaneda, Zimmer and Tang (2005) conducted a research among the elderly in Beijing Municipality. The study revealed that both men and women with better SES spent a higher percentage of active life than men and women with lower SES. Based on the Beijing Multidimensional Longitudinal Study of Ageing, Zimmer et al. (2010) found that the urban population had higher LE than the rural population at age 55. In the case of active life expectancy, people living in urban settings showed better performance than their rural counterparts. The higher socioeconomic standard of the urban people and greater access to health facilities in urban areas were highlighted as the major causes of such differences. The work of Zimmer, Hidajat and Saito (2015), based on the Chinese Longitudinal Healthy Longevity Study of 2002-05 and 2008-11, revealed that the increase in DFLE was much higher in urban areas than in rural areas. However, they did not find much impact of education on compression of morbidity. Analysing the information on aged people in China between 2000 and 2010, Lu et al. (2018) measured the changing morbidity-free life expectancy. Their study revealed that urbanisation, income, health infrastructure, and education significantly influenced disability reduction among the elderly Chinese.

From the literature review, we conclude that although the use of SMPH started in low mortality countries in the 1960s, presently, they are used to assess the health status of the population in both developed and developing countries. SMPH is also used widely to measure health inequality among socioeconomic groups. Most of the literature pointed towards the existing gender paradox and socioeconomic disparities in health.

1.3. Research gap and the significance of the study

The world is witnessing a transition in the health of the human population (Beaglehole, 2004). On the one hand, we observed an increasing life expectancy and declining fertility rates in the last fifty years. On the other hand, the prevalence of non-communicable diseases is increasing steadily. Also, health inequalities between the rich and poor are growing within and among countries. Let us look into the situation in India.

The mortality rate in India has dropped from 42.6 during 1901-1911[1] to 6.2 in 2018[2]. The crude birth rate has declined from 49.2[3] during 1901-1911 to 20.0 in 2018[2]. LE at birth has also improved significantly in India in the past hundred years (Table 1.1). However, significant interstate differences in fertility, mortality and life expectancy persist in India (Office of the Registrar General & Census Commissioner, India, 2009; Suryanarayana, Agrawal and Prabhu, 2011).

Table 1.1: Average life expectancy at birth in India (1901-1910 to 2014-2018)

Year	Life expectancy at birth (in years)		
	Males	Females	Total
1901-1910	22.6	23.3	22.9
1911-1920	19.4	20.9	20.1
1921-1930	26.9	26.6	26.8
1931-1940	32.1	31.4	31.8
1941-1950	32.5	31.7	32.1
1951-1960	41.9	40.6	41.3
1961-1970	47.1	45.6	46.4
1970-1975	50.5	49.0	49.7
1976-1980	52.5	52.1	52.3
1981-1985	55.4	55.7	55.5
1986-1990	57.7	58.1	57.7
1991- 1995	59.5	60.9	60.3
1996-2000	61.0	62.7	61.9
2001-2005	63.1	65.6	64.3
2006-2010	64.6	67.7	66.1
2011-2015	66.9	70.0	68.3
2014-2018	68.2	70.7	69.4

Sources: 1. Bhende and Kanitkar, 2008 (Page 227)

2. Office of the Registrar General & Census Commissioner, India, 2009, Compendium of India's Fertility and Mortality Indicators 1971-2007 (Page 14)

3. Registrar General, India, 2012, SRS Based Abridged Life Tables 2003-07 to 2006-10. (Pages 31 and 131)

4. Office of the Registrar General & Census Commissioner, India, 2017, SRS Based Abridged Life Tables 2011-15 (Page 6)

5. Office of the Registrar General & Census Commissioner, India, 2020, SRS Based Abridged Life Tables 2014-18 (Page 20)

[1] Bhinde and Kanitkar (2008), *Principles of Population Studies*, p-225
[2] Office of the Registrar General & Census Commissioner, India (2020), SRS Statistical Report 2018
[3] Premi MK, 2003, Social Demography: A Systematic Exposition, p-146

With increasing life expectancy, chronic illness has become more common in India. In 2005 in India, chronic diseases contributed to an estimated 53 per cent of mortality, and 44 per cent of DALYs lost (Reddy et al., 2005). In 1995-96, NCDs were responsible for almost 32 per cent of all hospital stays and 22 per cent of all outdoor visits, which increased to 40 per cent and 35 per cent, respectively in 2004 (Mahal, Karan and Engelgau, 2010). It indicates that the burden of NCDs in India is gradually rising. Since India is experiencing population ageing and a higher incidence of chronic diseases are found at the later period of life, only the mortality indicator to show the overall population health of the country seems to be unsatisfactory. Therefore, when the question arises of how healthy India's people are, we must look beyond mortality statistics and measure population health using such indices that take both mortality and morbidity into account. Although this type of study is gaining popularity worldwide, from the literature review section, it is clear that a small number of researchers have taken into account the SMPH to analyse population health in India.

The Global Burden of Disease Study has estimated the disease burden in terms of DALYs for different countries, including India. Recently, India State-level Disease Burden Initiative Collaborators (2017) have published their research on disease burden in India. Both the studies are gigantic work by nature that requires enormous human resources, substantial financial support from the government and other funding agencies, and sophisticated statistical tools and techniques that handle big data, compile the data from numerous sources and analyse it coherently. This type of study is perhaps impossible for any individual. Other studies that have estimated health expectancies/health gaps for the population of India includes the works of Shah et al. (2004), Thomas, James and Sulaja (2014), Bora and Saikia (2015) etc. However, this field of study has remained largely unexplored in India. More researches are needed to understand the effects of mortality and non-fatal health outcomes on the population health of this country. Therefore, in the present study, we have estimated the health status of the population of India and a few selected states using summary measures comprising mortality and morbidity data.

The World Health Organization (WHO) has defined health as "a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity" (WHO, 1946). This definition overcame the traditional negative approach of health as an absence of disease, death or disability. It emphasised an affirmative and broader sense of health incorporating physical and psycho-social domains (Breslow, 1972). Therefore, while estimating the population's health status, we should consider various health domains, such as physical performance, mental health, etc. In this context, we should remember that there are “internal views of health” (self-perceived health) and “external views of health” (depends on clinical assessments/observation). Some anthropologists and psychologists emphasise the internal perspective of health, where suffering has prime importance. According to public health experts, external views emphasise observed medical features instead of self-perception. To get the actual level of health, one should rely on “observation-oriented” statistics with systematic supplementation by “perception-oriented” information (Sen, 2006). Keeping this in mind, we have assessed the population health of India considering mortality, presence of disease or disability and perceived health state covering various domains of health.

As it is essential to find out how healthy the people are to understand the well-being and development, it is also necessary to know how health is distributed to recognise the extent of social justice in society (Sen, 2002). Good health enhances our ability to accomplish what we would like to achieve. Hence, inequality in health means discrimination in people’s capability to function (Sen, 2002). In this context, inequality is equivalent to inequity (Kawachi, Subramanian and Almeida-Filho, 2002). However, even if we use the term health inequality to designate disparity or differences in health achievements, we cannot deny that improvement of health in disadvantaged groups helps to improve the overall health status of a population. Therefore, assessing health inequalities among social groups is very important because it helps to identify the deprived sections.

The impact of socioeconomic status on health has been widely studied worldwide, particularly in the USA and Western Europe. In the 1990s, such studies gained momentum in developing countries. In India, several studies have tried to assess mortality variation by socioeconomic class (Ghosh and Kulkarni, 2004; Pradhan and Arokiasamy, 2010; Saikia and Ram, 2010; Po and Subramanian, 2011; Bhatia et al., 2018; Saikia, Bora and Luy, 2019; Asaria, 2019). A substantial number of studies regarding health inequalities were carried out from the perspective of health care utilisation, for example, utilisation of antenatal care and postnatal care, child immunisation, use of modern methods of contraception etc. (Kopparty, 1994; Joe, Mishra and Navaneetham, 2008; Balarajan, Selvaraj and Subramanian, 2011; Lauridsen and Pradhan, 2011; Singh et al., 2012; Goli, Doshi and Perianayagam, 2013; Prakash and Kumar, 2013, Goli S and Arokiasamy P, 2014). Mazumdar (2010) tried to analyse the determinants of unequal child malnutrition. Subramanian, Smith and Subramanyam (2006) investigated the disparity in mortality and health behaviour (e.g., substance use) between indigenous and non-indigenous groups in India. Mahal, Karan and Engelgau (2010) analysed the socioeconomic inequality in health care expenditure. Bhan, Rao and Kachwaha (2016) reviewed the trends and subjects of the studies in health inequality in India since the 1990s. They concluded that the early studies focussed on socioeconomic inequality by death rates, infectious and chronic ailments and nutrition. After 2005, the number of studies on health inequalities in India has increased, and the emphasis of the later studies shifted to NCDs, psychological health, injuries and risk factors. However, works on socioeconomic inequality in health expectancy are hardly found in India. Therefore, in the present study, we have measured the differences in healthy life expectancy by socioeconomic groups in India.

In a nutshell, our research is likely to contribute to a better understanding of population health in India. This work aims to provide information on the current health state of India's population using summary measures of population health, which are increasingly being considered as the basic input in public health policymaking. Our study on the inter-state variation in reporting poor health reflects some underlying causes for the observed differences. Identification of such factors may influence future policy decisions. Finally, we have calculated socioeconomic inequality in healthy life expectancy in India. To the best of our knowledge, no such studies are hitherto available in the context of India.

1.4. Research Questions

The following research questions have been selected for the present study:

1. In the context of available data on morbidity provided by the National Sample Survey (NSS), which approach is more suitable – incidence approach or prevalence approach – for estimating YLD?
2. What is the burden of disease in terms of Years Lost due to Disability (YLD) and Years of Life Lost due to premature mortality (YLL) among males and females in India?
3. Normally, life expectancy and healthy life expectancy are higher among females than males, but the proportion of years lived in poor health to total life expectancy are also higher among females. Is this gender paradox observed in India?
4. What are the recent changes found in Ailment-Free Life Expectancy (AFLE) and disease patterns in India?
5. Is the AFLE higher in urban areas than rural areas?

6. Can we use healthy life expectancies (HLE) derived from self-rated general health as a proxy to HLE derived from self-reported activity limitations or self-reported functional limitations?
7. How much inter-state variation is observed in HLE?
8. Does socioeconomic inequality in the reporting of poor health prevail in India?
9. How much variation is observed in healthy life expectancies among different socioeconomic groups?

1.5. Objectives of the Study

The objectives of the study are stated below:

1. To assess NSS data quality for selecting a suitable approach (incidence or prevalence approach) to compute YLD.
2. To estimate the disease burden among males and females of India in terms of YLD and YLL.
3. To examine whether the gender paradox in health is observed in India.
4. To study the recent changes in ailment-free life expectancy and disease patterns in India.
5. To analyse the rural-urban differences in AFLE in India.
6. To compare HLE derived from self-rated general health, self-reported activity limitations and self-reported functional limitations.
7. To measure the interstate variation in healthy life expectancy in six states of India.
8. To assess the inequality in reporting poor health across socioeconomic groups in India.
9. To obtain the age-specific death rates by socioeconomic groups and with the help of that data to estimate the HLE of different socioeconomic groups.

1.6. Source of data

The present study is based on data on both morbidity and mortality. Data on mortality has been collected from Sample Registration System (SRS), 2004; SRS life tables of India for 2001-2005, 2002-06 and 2014-18; and the second round of National Family Health Survey (NFHS-2), 1998. We have used the information on morbidity from the 60th round and the 75th round of the National Sample Survey (NSS), conducted in India, in 2004 and 2017-

18, respectively. We have also used information from the World Health Survey (WHS) held in India in 2003.

Below we have discussed some basic information about various data sources.

NSS was introduced in India in 1950 to collect information for socioeconomic planning and policymaking. It was the brainchild of the famous Indian statistician Dr Prasanta Chandra Mahalanobis. In March 1970, the NSS was reorganised and brought under the National Sample Survey Organization (NSSO), responsible for collecting and disseminating NSS data. NSS is a multi-stage, multi-purpose, cross-sectional household survey, conducted continuously in successive rounds on various topics, viz., employment and unemployment, consumer expenditure, agriculture and industries, healthcare, investment and capital formation etc. (Katyal et al., 2013). For the first time, NSS collected some data on morbidity in the 7th round (1953-1954). However, a full-fledged investigation on morbidity was carried out only in the 28th round in 1973-74. Since then, data on morbidity has been available from NSS Round 35 (1980-81), Round 42 (1986-87), Round 52 (1995-96), Round 60 (2004), Round 71 (2014) and Round 75 (2017-18). The 60th round (January - June 2004) of NSS covered the issues of morbidity and health care, household consumer expenditure and employment and unemployment. The details of the sample design of this round are available in the report “Morbidity, Health Care and the Condition of the Aged” (National sample Survey Organisation, 2006). The 75th round of NSS (July 2017 - June 2018) aimed to reflect social consumption on health and education. Sample design and estimation procedure of this round and important findings regarding health care are available in the report entitled “Key Indicators of Social Consumption in India: Health” (National Statistical Office, Government of India, 2019).

The World Health Survey (WHS) comprising 70 countries was started by the World Health Organization (WHO) “to provide data on a wide range of population health indicators such as health financing, health insurance, human resources for health, health state valuation, risk factors, mortality by cause, morbidity prevalence, reproductive and sexual health care and health system responsiveness” (Arokiasamy et al., 2006, p. XIII). In India, the International Institute for Population Sciences (IIPS) conducted the WHS from February to June 2003. The survey covered six Indian states, namely, Maharashtra, Uttar Pradesh, Rajasthan, Karnataka, West Bengal, and Assam. The six states comprised almost 47 per cent of the population of India at that time. It covered 10279 households, and the health questionnaire covered 9994 samples aged 15 years and above. The details of the sampling design and sampling techniques used in WHS are available from the report "Health System Performance Assessment, World Health Survey, 2003, India" (Arokiasamy et al., 2006).

The "Registration of Births and Deaths Act, 1969" established the compulsory registration of births and deaths in India. Still, the registration level was inadequate and inaccurate in several states and union territories. "With a view to generate reliable and continuous data on these indicators, the Office of the Registrar General, India initiated the scheme of sample registration of births and deaths in India popularly known as Sample Registration System (SRS) in 1964-65 on a pilot basis and on full scale from 1969-70" (Office of the Registrar General, India, 2006, p. 1). In SRS, a technique of dual reporting system (continuous recording and half-yearly survey) is employed for reliable information. The details about SRS structure and the sample design and sample size of SRS 2004 are available in the "Sample Registration System Statistical Report, 2004" (Office of the Registrar General, India, 2006).

The National Family Health Survey (NFHS) aims to provide demographic and health statistics for India. After the success of the NFHS-1 (1992-93), the second NFHS was carried out in 1998-99. The main objectives of the second NFHS were "to provide state and national estimates of fertility, the practice of family planning, infant and child mortality, maternal and child health, and the utilisation of health services provided to mothers and children" (IIPS and ORC Macro, 2000). Besides, it provided data on adult mortality, children and women's nutritional status, domestic violence, and the quality of health and family welfare services. Using the Woman's Questionnaire of NFHS-2, data was collected from 89,199 ever-married women aged 15-49 years. The details of the sample design are available in the report "National Family Health Survey (NFHS-2) 1998-99" (IIPS and ORC Macro, 2000).

1.7. Conceptual framework

It has already been mentioned in the introduction part that the SMPH can broadly be grouped into health expectancies (HE) and health gaps (HG) based on the survivorship curve.

The most popular and frequently used example of health expectancy is disability-free life expectancy (DFLE). Therefore, to understand the population's health status in India and selected states, we have used the indicator DFLE (or Ailment-Free Life Expectancy). DFLE "estimates the average expected years of life free of disability for a newborn in a population if current disability and mortality conditions continue to apply" (Mathers, 2002, p. 177). In DFLE, weight one is applied to the health state with no disability; and weight 0 is used for any other health state. The method of calculating DFLE involves the construction of the life table of a particular period.

Under the category of health gap, the most common indicator is disability-adjusted life years (DALYs), combining years lost due to disability (YLD) and years of life lost due to untimely death (YLL). The YLL component of DALY entails the concept of mortality gaps which Dempsey first proposed in 1947. She suggested Potential Years of Life Lost (PYLL) as an indicator of health. Instead of the number of deaths, PYLL uses time as the unit of measurement. Later PYLL leads to the development of other indicators, such as "period expected years of life lost, cohort expected years of life lost, and standard expected years of life lost" (Murray and Lopez, 1996, p. 10). The YLL is based on the Standard Expected Years of Life Lost (SEYLL) approach. In DALY, the estimation of time lived in non-lethal health conditions/diseases are based on "social preferences for different states of health as health state weights" (Mathers et al., 2001, p. 10). The weight ranges between 0 and 1. The weight 0 represents the state of optimum health, and 1 represents a state equivalent to death. Without discounting or age weight, YLL is calculated as:

YLL= N*L

where N= number of deaths, and L= Time lost due to premature mortality

YLD can be assessed using the incidence or prevalence approach. The Global Burden of Disease Study adopted the incidence approach to estimate YLD as:

"YLD = I x DW x L

where I is the number of incidence cases in the reference period, DW is the disability weight (in the range 0-1), and L is the average duration of the disability (measured in years)" (Mathers et al., 2001, p. 15).

The prevalence based YLD is expressed as:

"$YLD_x = P_x * DW_x$

where P_x is the number of cases in age group x prevalent at any point of time during the reference period, and DW_x is the disability weight" (Mathers et al., 2001, p. 122).

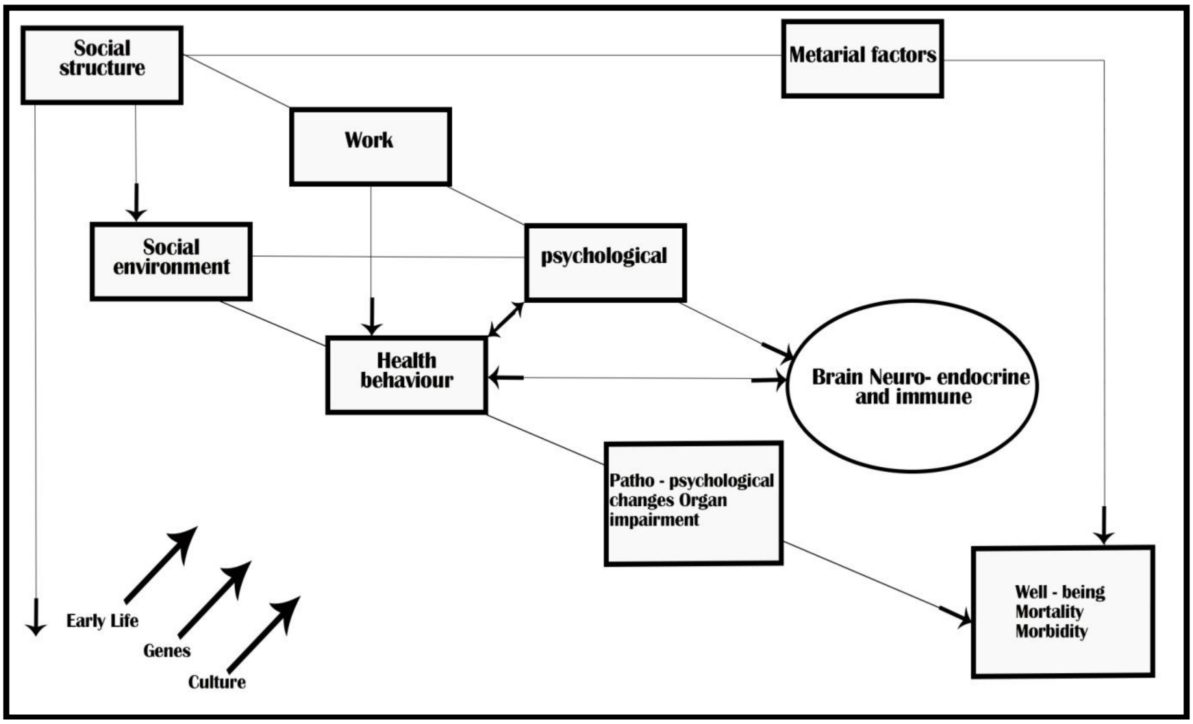
Health outcomes are always associated with the distributional aspect of health. Assessing health inequality involves a minimum of two variables, one related to health status (measured in terms of self-reporting, the clinically diagnosed incidence of prevalence rates of diseases or mortality etc.) and other related to SES (measured in terms of occupation, income, education etc.).

What are the reasons behind health inequality among various socioeconomic groups? Since 1980 three theories have been developed to explain health disparities. These are the psycho-social model, life-course explanation and materialist explanation of health inequalities. According to psycho-social analysis, health inequality occurs due to the psychological effects of stressful conditions at home or workplace or low social status (Bartley, 2004). The life course analysis of inequality in health became popular in the 1990s. This theory emphasises the impact of pre-conception and early childhood exposures that lead to health inequality among adults (Smith, Blane and Bartley, 1994). The materialist or structural explanation of health inequality draws attention to the social structure that exposes some sections of the population to greater vulnerability (Blane, Bartley and Smith, 1997). The structural factors can broadly be divided into two groups: factors which are aetiological agents (e.g., income, education, occupation, diet, housing etc. that are potential causes of disease) and factors which are non-aetiological agents (social policies regarding the provision of high-quality health services at a subsidised rate or old age pension). The importance of materialist factors has been identified in several studies. Mackenbach and colleagues (1997) found that health inequality was comparatively low in Mediterranean countries of Europe like Italy, Spain and Greece than in northern countries like Britain. Though these southern European countries are not very rich, good climate, cheaper housing where residents are not exposed to cold or damp, and the Mediterranean diet have helped them to lower health inequality (Mitchell, Blane and Bartley, 2002).

Besides psycho-social, life-course and materialist factors, Bartley (2004) has explained the impact of culture/behaviour and political economy on health inequality. According to him, Differences in norms, beliefs and values act in a way that members of lower social class are less likely to consume alcohol reasonably, refrain from smoking and carry out exercise regularly. Political economy is vital in analysing health inequality because the distribution of power influences the provision of services, quality of surroundings etc.

An eminent public health advocate, M. Marmot (2006), has established a causal model of health inequality (Fig. 1.2). His model shows the causal pathways that link social structure to human well-being, mortality and morbidity. Marmot (2006) emphasises that a person's social position shapes his/her early life and the social and work environment in the later period of life. Thus social status indirectly influences an individual's psychological health and health behaviour which ultimately affects the health and well-being of a person. Early life conditions, genes, and culture are directly related to a person's health behaviours that may lead to biological changes in a body to cause disease. Social structure is also linked to the material factors (like income, education etc.) that determines personal well-being. Thus unequal social structure makes some people more vulnerable to ill health.

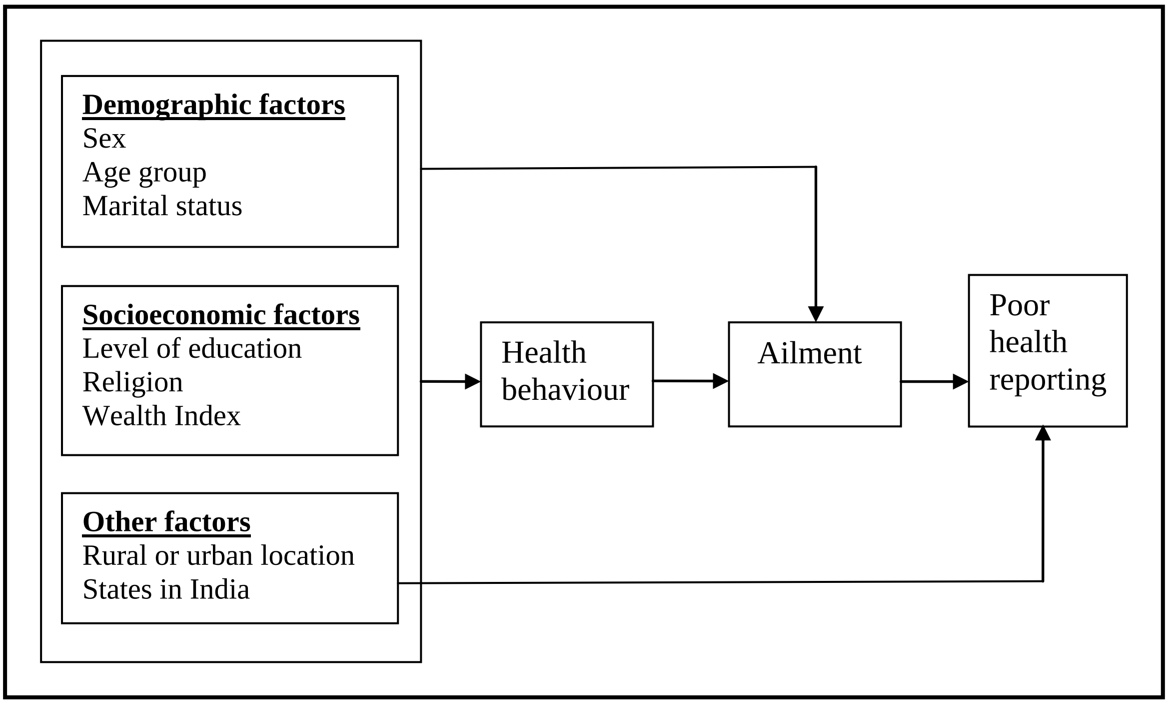
Fig. 1.2: Pathways of social influence on health



Source: Michael Marmot (2006) in Social Causes of Social Inequalities in Health, p. 49

Based on the above discussion and availability of data, the following framework (Fig. 1.3) has been adopted in our study to explain the probability of poor health reporting.

Fig. 1.3: A conceptual framework showing the factors related to the reporting of poor health



Various factors directly or indirectly are associated with the reporting of poor health. A person suffering from any disease is expected to report poor health. The ailments are sometimes related to personal health behaviours (such as alcohol consumption, smoking, unsafe sexual practice, etc.), which are affected by various demographic (e.g., marital status) and socioeconomic factors (e.g. low income). For example, poor people are more likely to drink excessive country-liquor which damages their health. Demographic characteristics like age and sex are directly linked to the prevalence of various diseases. Education and wealth determine the knowledge and access to healthcare, influencing people's health. High levels of air pollution and physical inactivity in urban areas are associated with ill health. However, lower healthcare facilities in rural areas may affect the diagnosis of diseases and hence the reporting. Finally, interstate variation in public health facilities directly impacts the people's health status. The reporting of poor health also depends on the perception of health which varies from state to state due to different socio-cultural norms and practices.

1.8. The organisation of the thesis

There are seven chapters in the thesis. We have organised the thesis in the following manner:

The introductory chapter (Chapter 1) presents the basic concept of SMPH, a review of the literature on SMPH, the research gap, and the study's significance. It also includes research questions, objectives, database, and conceptual framework. Finally, the organisation of the thesis has been outlined.

To assess the disease burden in terms of YLD, we need information on incidence and prevalence rates and duration of illness. We also should check the data quality to adopt the appropriate technique for YLD computation. For this purpose, Chapter 2 presents the assessment of data to check the consistency among incidence, prevalence and duration. Chapter 3 provides the estimation of YLD and YLL for females and males in India. This chapter elaborates on the methodology to compute YLD and YLL based on available data. In chapter 4, we have analysed the temporal changes in ailment-free life expectancies and the burden of communicable and non-communicable diseases in India. In chapter 5, we have examined healthy life expectancy in India based on self-rated health and self-reported disabilities. This chapter also includes a comparative analysis of healthy life expectancies among six large states in India. Chapter 6 presents the socioeconomic inequalities in HLE and self-reported poor health in India. The conclusion of our study is stated in chapter 7.

Chapter 2

Assessment of quality of data for selecting incidence or prevalence approach for the estimation of the burden of disease

2.1. Introduction

Both mortality and morbidity indicators are used to assess health (or ill-health) in any population. Most health measures are based on incidence rates or prevalence rates. We know that incidence is the rate at which new events (e.g., ailments or deaths) occur in a population in a defined time period. Prevalence refers to the proportion of existing cases (rather than new cases) at a certain point in time, that is, point prevalence (e.g., on the day of survey) or within a definite time period, that is, period prevalence (e.g., a specific year). Although we commonly use the term prevalence rate, some experts criticise it as prevalence does not measure the "rapidity of change" (Abramson, 2004, p. 514). When the prevalence type is not specified, it usually implies point prevalence (Young, 2005).

The burden of disease in terms of DALY measures the total units of time lost due to premature death and non-fatal health outcomes. The mortality component of DALY obviously entails the incidence perspective as the death rate is an incidence rate. In contrast, we can use both incidence and prevalence measures to quantify morbidity. To calculate the time spent in disability, one may use point prevalence, "adjusted for the seasonal variation if present, and estimate the total time lived with the disability as prevalence *times* one year. The alternative is to measure the incidence of disabilities and the average duration of each disability. Incidence *times* duration will then provide an estimate of the total time lived in disability" (Mathers et al., 2001, p. 9). The Global Burden of Disease Study (GBDS) applies the incidence perspective for three reasons: "First, the method of calculating time lived with disability is more consistent with the method for calculating time lost due to premature mortality. Second, an incidence perspective is more sensitive to current epidemiological trends. Third, measuring incidence or deriving it from prevalence data and information on case-fatality and remission rates imposes a level of internal consistency and discipline that would be missing if prevalence data were used uncritically" (Murray and Lopez, 1996, p. 9). Following the GBD study, we may consider applying the incidence perspective to estimate the YLD for the population of India. But before using the incidence perspective, we need to assess the quality of the data to check if consistency exists among incidence, prevalence and duration of ailments and if incidence and duration of illness can be used for this study.

2.2. Methodology

Our analysis is based on the 60th round (2004) and the 75th round (2017-18) of the National Sample Survey (NSS) conducted in India. Information on the incidence rate and prevalence of diseases/conditions is available from both rounds. The morbidity and health care schedule (25.0) of the NSS round 60 and the household social consumption on health schedule (25.0) of the 75th round collected data about the 'spells of ailment' of household members during 15 days before the survey. In the 60th round, information was collected up to five spells of ailment. After restructuring the data, we get the number of persons who reported at least one spell of ailment as 36510. Among them, the number of persons who reported to have experienced the second, third, fourth and fifth spell of ailment was 1889 (5.17 per cent), 347 (0.95 per cent), 49 (0.13 per cent) and 8 (0.02 per cent), respectively. Of those who suffered from any ailment within the reference period, most (94.83 per cent) suffered from only one spell of illness.

The 75th round of NSS collected data up to eight spells of ailment. The restructured data shows that 39902 persons reported at least one spell of illness. Among them, the number of persons who reported to have experienced the 2nd, 3rd, 4th, 5th, 6th, 7th and 8th spell of ailment was 2648 (6.1 per cent), 550 (1.3 per cent), 107 (0.2 per cent), 25 (0.1 per cent), 5 (0.0 per cent), 2 (0.0 per cent) and 1 (0.0 per cent), respectively. Therefore, 92.3 per cent experienced only one spell of ailment within the reference period. While analysing both the 60th and the 75th rounds of NSS data on morbidity, we have restricted our study to the first spell of ailment.

During the survey, questions were asked on the "nature of the ailment", "status of ailment", and "total duration of ailment (in days)" in both rounds (NSSO, 2006; NSO, Government of India, 2019). Information on 40 types of diseases is available from the 60th round of NSS. Besides, there are two more categories – 'other diagnosed ailments' and 'other undiagnosed ailments'. The 75th round of NSS provided 58 types of reported diagnosis and/or main symptoms along with two additional categories – 'symptom not fitting into any of the above categories' and 'could not even state the main symptom'. Following the official report of the 75th round of NSS on health, we did not consider childbirth as an ailment because childbirth is a physiological process. Here, it is necessary to mention that the NSS data on morbidity is self-reported against the medically certified/tested one.

Status of ailment in terms of the time of initiation and time of end/continuation till survey date has been grouped into four categories. These are:

Status 1: Started more than 15 days ago and is continuing (on survey date)

Status 2: Started more than 15 days ago and has ended (before survey date)

Status 3: Started within 15 days and is continuing (on survey date)

Status 4: Started within 15 days and has ended (before survey date)

Status 1 and 3 of any ailment are used to estimate point prevalence, and status 3 and 4 of any ailment have been used to calculate incidence. In our analysis, the incidence rate has been calculated as:

Incidence rate = (Number of persons reporting initiation of any ailment in the reference period of 15 days preceding the date of survey/ Total population)*100,000

The prevalence rate (point prevalence at the time of the survey) has been calculated as:

Prevalence rate = (Number of persons reporting any ailment at the time of survey/ Total population)*100,000

2.3. Results

2.3.1. Inconsistency in data

2.3.1a. Inconsistency between "ailment status" and "duration of ailment"

We have estimated the incidence, point prevalence, and period prevalence for each disease using the information on the duration of illness and the status of illness. Ideally, the reported "status of ailment" should match with the "duration of ailment". However, we identified discrepancies in reporting these two variables in our analysis of the 60th round of NSSO data. For example, in the case of diarrhoea/dysentery, it is found that among 145 persons who reported their ailment status as 1 (and hence, the duration must obviously be more than 15 days), 58 persons also reported their duration of illness as 15 days or less (Table 2.1). Except for under-nutrition, a similar discrepancy where status is noted as 1 but the duration is mentioned as 15 days or less exists for all other ailments.

As a corrective measure, we may take any of the following two steps:

(a) All the cases of status 1 (Started more than 15 days ago and is continuing) can be considered as more than 15 days duration without specifying the exact duration. For example, suppose there are 7 cases where the duration of ailment is reported as 4 days and status as 1. In that case, these 7 persons will be counted under status 1.

Table 2.1: Cases of Incidence, point prevalence and period prevalence of diarrhoea/dysentery, 2004

Duration (in days)*	**Status of illness				Period prevalence	Point prevalence	Incidence
	1	2	3	4	1+2+3+4	1+3	3+4
1	1	4	13	38	56	14	51
2	3	19	51	195	268	54	246
3	2	30	48	241	321	50	289
4	7	37	44	151	239	51	195
5	7	23	39	130	199	46	169
6	3	11	27	62	103	30	89
7	7	11	26	59	103	33	85
8	2	12	20	39	73	22	59
9	0	1	4	5	10	4	9
10	4	12	38	34	88	42	72
11	0	2	2	5	9	2	7
12	2	1	8	5	16	10	13
13	0	1	0	2	3	0	2
14	1	4	3	3	11	4	6
15	19	11	14	6	50	33	20
1-15	58	179	337	975	1549	395	1312
16-30	50	18	2	2	72	52	4
31-60	16	4	1	2	23	17	3
61-180	7	0	1	0	8	8	1
>180	14	1	1	0	16	15	1
Total	145	202	342	979	1668	487	1321

Source: Computed from the unit level data of NSS, Round 60, 2004

Note: Persons with age over 100 years are not considered (<0.1 per cent of persons were reported to be over 100 years)

*Persons with missing duration are not included (<1 per cent of the sample)

**Status 1= Started more than 15 days ago and is continuing
Status 2= Started more than 15 days ago and has ended
Status 3= Started within 15 days and is continuing
Status 4= Started within 15 and has ended

(b) A household member whose duration of ailment was 15 days or less but ailment status was reported as status 1 (Started more than 15 days ago and is continuing), can be considered under status 3 (Started within 15 days and is continuing). For example, if there are 7 cases where the duration of ailment are reported as 4 days and status as 1, these 7 cases will be shifted to status 3, and the duration of illness will remain 4 days.

We also noticed that a few respondents reported their status as 3 (Started within 15 days and is continuing) or 4 (Started within 15 and has ended) but the duration of illness as more than 15 days. For example, in Table 2.1, 1321 respondents stated their status as 3 or 4 (and hence, the duration must be less than 15 days), but 9 persons (4+3+1+1) also reported their duration of illness more than 15 days. Appendix 2.1 shows the mismatch in reported "status of ailment" and "duration of ailment" for hypertension. Interestingly, a similar discrepancy was also observed in the 75th round of NSS data. For example, table 2.2 shows a discrepancy between reported status and duration of heart disease.

Table 2.2: Cases of Incidence, point prevalence and period prevalence of heart disease, 2017-18

Duration (in days)	*Status of illness				Period prevalence	Incidence	Point Prevalence
	1	2	3	4	1+2+3+4	3+4	1+3
1	0	0	8	11	19	19	8
2	0	25	53	139	217	192	53
3	0	44	107	284	435	391	107
4	0	30	83	233	346	316	83
5	0	39	93	277	409	370	93
6	0	18	61	118	197	179	61
7	0	26	98	126	250	224	98
8	1	10	47	53	111	100	48
9	0	2	11	12	25	23	11
10	1	18	50	67	136	117	51
11	0	2	3	4	9	7	3
12	0	10	19	16	45	35	19
13	0	3	3	1	7	4	3
14	0	1	5	3	9	8	5
15	33	8	27	5	73	32	60
1-15	35	236	668	1349	2288	2017	703
16-30	79	23	2	1	105	3	81
31-60	30	3	0	0	33	0	30
61-180	29	0	1	0	30	1	30
>180	114	0	0	0	114	0	114
Total	287	262	671	1350	2570	2021	958

Source: Computed from the unit level data of NSS, Round 75, 2017-18

Note: *Status 1= Started more than 15 days ago and is continuing
Status 2= Started more than 15 days ago and has ended
Status 3= Started within 15 days and is continuing
Status 4= Started within 15 and has ended

It is found that 287 persons reported their status as 1 (so, the duration should be more than 15 days), but 35 of them also said their duration of illness was 15 days or less. In the 75th round of NSS data, apart from seven types of diseases/reported diagnoses (HIV/AIDS, other sexually transmitted infections, other metabolic and nutritional diseases including obesity, decreased hearing, poisoning, intentional self-harm, and assault), similar discrepancy where the status of ailment did not match with the duration of ailment was found for all other diseases/conditions. Besides, a few respondents stated their status as 3 or 4 but the duration of illness as more than 15 days. For example, in Table 2.2, among 2021 respondents who reported their status as 3 or 4 (and hence, the duration must obviously be less than 15 days), 4 persons also stated their duration of illness more than 15 days.

The number of cases showing the mismatch between the reported “status of ailment” and the “duration of ailment” is lower in the 75th round than the 60th round of NSS, particularly in the case of incidence. In the 75th round, the highest number of cases for any ailment, where the respondents reported their status as 1, but the duration 15 days or less, was 102 (for all other fevers including typhoid, fever with rash/eruptive lesions and fevers of unknown origin). In the 60th round, the highest case of similar mismatch was 299, observed for ‘other diagnosed ailments’.

In the 75th round, the maximum number of erroneous cases where the respondents stated their status as 3 or 4 but the duration as more than 15 days was only four (found in case of heart disease). In contrast, analysing the 60th round of NSSO data, we found that the number of cases where the respondents stated their status as 3 or 4 but the duration as more than 15 days was as high as 77 for the category ‘other diagnosed ailments’. Also, 51 cases of a similar type of mismatch were recorded for disorders for joints and bones.

2.3.1b. Inconsistency in reported morbidity by sex

During the computation of prevalence or incidence rate, one must remember that the denominators for prostatic disorders and gynaecological disorders should be the total male and female populations, respectively. In the NSSO Report no. 507, “Morbidity, Health Care and the Condition of the Aged”, the denominator was taken as the total population (male + female) for these two ailments (NSSO, 2006), which is incorrect. More surprisingly, cases of gynaecological disorders are shown among males and prostatic disorders among females (e.g. Appendix A, Table 39, pages A-160, A-164), which are absurd. Below we have reproduced some portion of a table from the NSS report no. 507 to highlight the facts mentioned above (Table 2.3).

Table 2.3: Selected data reproduced from Table 39, NSS Report No. 507

"Table (39): Number per 1,00,00 of persons reporting onset of specific ailments during last 15 days and average duration of ailment by broad ailment type

All-India								Rural + Urban
Broad ailment type	Incidence rate of ailment during last 15 days			Average duration of ailment in days (0.0)			Persons reporting onset of ailment during last 15 days	
	male	female	persons	male	female	Persons	estd. no. (00)	Sample
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
...	...	...	...	...	...	...	...	...
heart disease	18	21	19	*66.4*	*113.6*	*91.0*	1863	120
hypertension	39	65	52	*230.6*	*132.0*	*169.8*	4961	200
...	...	...	...	...	...	...	...	...
prostatic disorders	3	*1*	2	22.3	*6.5*	18.6	190	12
gynaecological disorder	*3*	64	32	*2.0*	17.2	16.6	3124	148
...	...	...	...	...	...	...	...	...
disability speech	2	0	1	*999.0*	0	*999.0*	90	2
...	...	...	...	...	...	...	...	...
sample persons	196699	188356	385055	x	x	x	X	x"

Source: Report no. 507, Appendix A, pp. A-164 & A-165 (NSSO, 2006)

The report, "Key Indicators of Social Consumption in India: Health", based on the 75th round of NSS, did not produce the disease-specific tables for males and females. Therefore, we cannot check if there is any inconsistency in reported morbidity by sex. However, while estimating the prevalence and incidence rates using the 75th round of NSS data, we are careful enough to consider only the total female population as the denominator for the reported diagnosis of 'pregnancy with complications before or during labour (abortion, ectopic pregnancy and hypertension)' and 'complications in mother after birth of child'.

2.3.1c. Inclusion of dead individuals in the calculation of incidence rates

While calculating the incidence rate, we did not consider the household members who died in the last 365 days because the question "whether ailing anytime in the last 15 days" is related to household members only. Dead persons are not counted as household members.

Surprisingly, the NSSO report (No. 507) based on NSS-Round 60 shows that the household members who died in the last 365 days were included in the denominator for calculating incidence rates (e.g. Table 39, Appendix A, A-165 of Report no. 507). The sample size of such persons is 1717, and the total sample size including such persons is 385055. This leads to slight differences in incidence rates between the NSSO report and our estimation. The inconsistency that the dead individuals were included in the calculation of incidence rates was detected from the sample size used in the denominator for calculating the incidence rate provided in the report. Surprisingly, such basic information is not available in the health report of the 75th round of the National Sample Survey.

2.3.2 Estimation of prevalence and incidence rates

2.3.2a. Prevalence and incidence rates of ailments in India, 2004 (NSS, Round 60)

Our estimation of point prevalence and incidence rate was based on the status of ailment reported by the respondents. We have taken the total male and female populations as denominators in our calculation of prostatic disorders and gynaecological disorders, respectively. Also, we considered only male cases for prostatic disorders and female cases for gynaecological disorders. We have also restricted our analysis for people aged 100 years or less because, according to the data, there were persons living more than 200 years which are an obvious recording error. However, among 383338 samples, only 50 were above 100 years (<0.01 per cent). Below prevalence and incidence rates of various ailments have been presented.

Table 2.4: Prevalence of ailments by ailment types in India, 2004

Ailment types	Prevalence cases (Sample, unweighted)[a]	Prevalence per 100,000[1]		
		Total	Male	Female
"Diarrhoea/Dysentery	497	127.6	129.6	125.5
Amoebiosis	75	19.9	19.4	20.5
Worm infestation	70	16.4	20.0	12.6
Gastritis/Gastric or peptic ulcer	1056	247.1	214.4	281.5
Hepatitis/Jaundice	154	30.9	41.0	20.2
Disorders of joints and bones	2365	570.7	429.6	719.0
Bronchial asthma	1394	300.1	354.0	243.4
Respiratory disease including ear/nose/throat ailment	1380	343.5	352.9	333.6
Fever of unknown origin	1799	535.0	492.8	579.3
Tuberculosis	648	108.6	127.1	89.1
Hypertension	2175	463.3	352.8	579.3

Heart disease	1442	244.0	261.9	225.3
Diseases of kidney/urinary system	480	80.0	92.3	67.0
Psychiatric disorders	294	62.0	58.5	65.7
Neurological disorders	937	174.1	156.5	192.5
Diabetes mellitus	1661	333.1	341.9	323.8
Malaria	202	56.8	51.3	62.6
Gynaecological disorders	459	174.9	NA	174.9
Prostatic disorders	53	14.3	14.3	NA
Cataract	697	143.1	119.4	167.9
Conjunctivitis	123	28.2	28.9	27.5
Glaucoma	93	23.7	20.2	27.4
Sexually transmitted diseases	22	4.9	1.7	8.2
Goitre	42	9.5	4.5	14.8
Anaemia	176	35.7	19.5	52.7
Under-nutrition	35	9.9	11.4	8.3
Filariasis/Elephantiasis	52	10.7	5.3	16.4
Whooping cough	390	107.0	100.4	114.0
Diseases of skin	591	184.1	191.3	176.6
Diptheria	15	4.6	5.9	3.2
Tetanus	13	2.3	2.9	1.8
Mumps	36	12.7	9.2	16.4
Eruptive	48	21.9	19.8	24.0
Cancer and other tumours	359	47.1	42.4	52.1
Diseases of mouth/teeth/gum	187	54.4	40.2	69.2
Visual disability (excluding cataracts)	442	100.2	87.3	113.8
Locomotor disability	772	167.2	178.1	155.7
Hearing disability	351	85.1	85.7	84.4
Speech disability	76	25.1	30.8	19.0
Accidents/injuries/burns/ fractures/poisoning	1019	190.9	255.6	122.8
Other undiagnosed ailments	628	169.8	153.2	187.3
Other diagnosed ailments”	3353	784.5	663.1	912.0
Total	26661			

Source: National Sample Survey Organisation, 2006 (for types of ailments)
Computed from the unit level data of NSS, Round 60
Note: [1]Prevalence has been computed using sample weights
[a] Person of age over 100 years are not considered; NA = Not applicable

Table 2.5: Incidence rates of various ailments in India, 2004

Ailment types	Incidence cases (Sample, unweighted)[a]	Incidence rate in 15 days per 100,000[1]		
		Total	Male	Female
“Diarrhoea/Dysentery	1326	382.8	386.6	378.8
Amoebiosis	82	21.4	19.4	23.4
Worm Infestation	93	28.4	27.2	29.7
Gastritis/Gastric or peptic ulcer	455	119.9	85.4	156.3

Hepatitis/Jaundice	60	14.2	16.4	11.8
Disorders of joints and bones	363	91.3	64.1	119.9
Bronchial Asthma	220	61.6	76.5	46.0
Respiratory disease including ear/nose/throat ailment	1579	444.9	474.7	413.6
Fever of unknown origin	4642	1488.0	1400.2	1580.2
Tuberculosis	41	6.0	8.9	3.0
Hypertension	200	51.7	38.7	65.4
Heart disease	119	19.4	18.1	20.8
Diseases of kidney/urinary system	94	18.8	19.2	18.4
Psychiatric disorders	24	5.8	7.9	3.5
Neurological disorders	122	36.2	27.8	45.1
Diabetes mellitus	66	15.6	14.6	16.6
Malaria	370	119.8	115.4	124.4
Gynaecological disorders	146	63.7	NA	63.7
Prostatic disorders	9	3.0	3.0	NA
Cataract	40	6.2	6.0	6.4
Conjunctivitis	61	18.4	19.0	17.9
Glaucoma	12	2.7	0.7	4.8
Sexually transmitted diseases	8	1.1	0.2	2.1
Goitre	10	1.4	1.6	1.1
Anaemia	43	9.3	3.0	16.0
Under-nutrition	10	1.6	0.03	3.2
Filariasis/Elephantiasis	7	0.7	0.5	0.9
Whooping cough	524	165.7	164.1	167.3
Diseases of skin	206	68.0	63.1	73.1
Diptheria	29	10.7	15.0	6.3
Tetanus	6	1.4	1.5	1.3
Mumps	60	18.1	10.7	25.8
Eruptive	70	34.7	25.0	44.8
Cancer and other tumours	41	8.1	11.7	4.3
Diseases of mouth/teeth/gum	199	60.9	48.1	74.4
Visual disability (excluding cataracts)	37	8.7	3.3	14.3
Locomotor disability	79	18.0	13.3	23.0
Hearing disability	37	11.1	14.4	7.6
Speech disability	2	0.9	1.8	0.0
Accidents/injuries burns/ fractures/poisoning	468	139.4	194.3	81.7
Other undiagnosed ailments	396	113.7	108.3	119.3
Other diagnosed ailments"	2348	727.1	685.7	770.5
Total	14704			

Source: National Sample Survey Organisation, 2006 (for types of ailments)
Computed from the unit level data of NSS Round 60

Note: [1]Incidence rates have been computed using sample weights

[a] Person of age over 100 years are not considered; NA = Not applicable

It is evident from Table 2.4 that among reported ailments, the prevalence was relatively high (above 300 per 100,000 persons) in case of disorders of joints and bones (570.7), hypertension (463.3), respiratory disease (343.5), bronchial asthma (300.1) and diabetes mellitus (333.1). On the other hand, among the diagnosed diseases, a comparatively higher incidence rate (above 100 in 15 days per 100,000 persons) was found in cases of respiratory disease (444.9), diarrhoea/dysentery (382.8), whooping cough (165.7), accidents/injuries (139.4), gastritis/gastric/peptic ulcer (119.9) and malaria (119.8) (Table 2.5). For some diseases, both point prevalence and incident rates were considerably higher (1.5 times or more) among females than males, such as hypertension, disorders of joints and bones, anaemia, STDs, mumps, filariasis/elephantiasis and diseases of mouth/teeth/gum. In contrast, incidence rates and prevalence were found markedly higher (1.5 times or more) among males than females in the cases of bronchial asthma, diphtheria, and accidents/injuries.

2.3.2b. Prevalence and incidence rates of ailments in India, 2017-18 (NSS, Round 75)

The report "Key Indicators of Social Consumption in Health: India, NSS 75th Round" was published in November 2019. Unlike the NSSO report on the health of Round 60 (NSSO Report no. 507), this report (NSS KI 75/25.0) did not provide detailed analysis and tables of disease-specific prevalence and incidence rates. In the report, the ailments were "clubbed into seven broad categories: (i) infections (including fevers, jaundice, diarrhoea/dysentery), (ii) endocrine or metabolic (including diabetes and thyroid diseases), (iii) cardio-vascular (including hypertension and heart disease), (iv) respiratory, (v) musculo-skeletal (including joint pain, back & body aches), (vi) psychiatric or neurological, and (vii) other ailments" (NSO, Government of India, 2019, p. 10). However, it is crucial to know the disease-specific morbidity rate to identify the impact of a particular disease (say tuberculosis) and evaluate the benefits of policy interventions. Hence, we have estimated India's disease-specific prevalence and incidence rates using the 75th round of NSS data.

We have calculated the point prevalence and incidence rate of various diseases based on the status of the ailment of household members. Among 555352 household members, 39902 persons reported their status of ailment. Our analysis included people aged 100+ as the highest reported age was 115, and only 26 persons(<.01 per cent) stated their age 110 years or above. We have not included childbirth in our analysis because childbirth is not an ailment but a physiological process. The point prevalence and incidence rate of various diseases in India for 2017-18 have been presented in Table 2.6 and 2.7, respectively.

We observed that the prevalence rate was exceptionally high (above 1000 per 100,000 persons) for two chronic diseases – hypertension (1060.7) and diabetes (1000.6). A recent study, particularly designed to assess diabetes and hypertension prevalence among Indian adults, found that the prevalence of these two diseases "is high in middle and old age across all geographical areas and sociodemographic groups in India, and hypertension prevalence among young adults is higher than previously thought" (Geldsetzer et al., 2018, p. 3 of 20). Therefore, it is crucial to prevent and control diabetes and hypertension to reduce the overall morbidity rate in India. Among other reported diagnosis/main symptoms, a relatively high (above 300 per 100,000 persons) prevalence rate was observed in joint or bone disease (457.8) and all other fevers, including typhoid, fever with rash/eruptive lesions and fevers of unknown origin (324.5).

Regarding incidence rate, the reportedly highest rate was observed in the case of all other fevers (1509.3 per 100,000), followed by acute upper respiratory infections (385.9 per 100,000) and fever with consciousness or altered consciousness (187.1 per 100,000). In case of change/irregularity in menstrual cycle and other gynaecological and andrological disorders including infertility, prevalence and incident rates were more than 100 times higher among females than males. As andrological and gynaecological disorders along with menstrual problems had not been considered as a separate category, an extreme gender difference in prevalence and incidence rates occurred in the above case. Apart from it, both point prevalence and incident rates were considerably higher (1.5 times or more) among females compared to males for the diagnosis/symptom of worm infestations, anaemia, other endocrinal, metabolic and nutritional disorder including obesity, hearing loss, pain in abdomen due to gastric or peptic ulcers/acid reflux, back or body aches, and burns and corrosions. On the other hand, we observed that point prevalence and incidence rates were distinctly higher (1.5 times or more) among males than females in case of tuberculosis, illness in newborns, accidental injury, other sexually transmitted diseases and accidental drowning and submersion. Therefore, the policymakers should consider the gender dimension of disease prevalence during policy intervention.

Table 2.6: Prevalence of ailments by ailment types in India, 2017-18

Ailment types	Prevalence cases (Sample, unweighted)[a]	Prevalence per 100,000[1]		
		Total	Male	Female
"Fever with consciousness or altered consciousness	219	47.1	37.0	57.9
Malaria	90	21.4	24.4	18.2
Fever due to diphtheria, whooping cough	236	35.1	36.6	33.5
All other fevers, including typhoid, fever with rash/eruptive lesions and fevers of unknown origin	1787	324.5	313.7	336.0
Tuberculosis	249	32.8	50.5	13.9
Filariasis	36	3.2	3.1	3.3
Tetanus	4	0.1	0.2	0.0
HIV/AIDS	18	1.4	1.4	1.5
Other sexually transmitted diseases	8	1.3	2.2	0.3
Jaundice	100	11.1	10.2	12.1
Diarrhoea/dysentery/increased frequency of stools	121	17.9	22.8	12.7
Worms infestations	25	5.4	1.3	9.7
Cancers and occurrence of any growing painless lump in the body	396	25.9	27.4	24.0
Anaemia	241	38.9	25.9	61.3
Bleeding disorders	109	11.3	9.2	13.6
Diabetes	6538	1000.6	964.3	1039.5
Under-nutrition	30	6.1	6.0	6.3
Goitre and other diseases of thyroid	817	148.4	48.3	255.4
Other metabolic disorders, including obesity	180	25.0	13.5	37.3
Mental retardation	112	18.2	17.4	19.0
Mental disorders	283	39.0	45.2	32.5
Headache	257	62.3	32.4	94.3
Seizures or unknown epilepsy	175	19.0	19.7	18.2
Weakness in limb muscles and difficulty in movements	435	74.0	71.8	76.2
Stroke/hemiplegia/sudden onset weakness in half of body or loss of speech	393	49.2	55.0	42.9

Others including memory loss, confusion	94	16.7	15.4	18.0
Discomfort/pain in the eye with redness or swellings//boils	125	23.0	19.5	26.8
Cataract	93	12.2	5.0	19.8
Glaucoma	38	5.6	4.3	6.9
Decreased vision (chronic, not possible to correct with glasses)	65	8.6	7.1	10.2
Eye problem: Others (Strabismus, nystagmus, ptosis and adnexa)	56	11.6	6.5	17.1
Earache with discharge/bleeding from ear/infections	70	9.5	12.3	6.6
Decreased/loss of hearing	54	10.3	6.8	14.1
Hypertension	6321	1060.7	912.4	1219.3
Heart disease: Chest pain, breathlessness	1942	237.2	255.2	218.0
Acute upper respiratory infections	958	158.9	138.8	180.4
Cough with sputum with or without fever but not TB	263	43.5	46.7	40.1
Bronchial asthma/recurrent episode of wheezing and breathlessness	1205	209.9	203.0	217.4
Diseases of mouth, teeth, gums	108	19.9	18.0	21.9
Pain in abdomen: Gastric and peptic ulcers/ acid reflux	1006	181.5	149.0	216.2
Lump or fluid in abdomen or scrotum	171	26.9	24.0	30.1
Gastrointestinal bleeding	69	10.2	10.6	9.8
Skin infection (boil, abscess, itching) and other skin diseases	639	143.4	163.3	122.0
Joint or bone disease/pain or swelling in any of the joints	2315	457.8	298.6	628.0
Back or body aches	691	133.5	85.9	184.4
Any difficulty or abnormality in urination	356	39.4	43.0	35.5
Pain in pelvic region/RTI/Pain in the male genital area	106	17.3	20.7	13.9
Change/irregularity in menstrual cycle or excessive bleeding/pain during menstruation and any other gynaecological and andrological disorders, including male/female infertility	130	26.5	0.5	54.4
Pregnancy with complications before or during labour (abortion, ectopic pregnancy, hypertension)	51	24.5	NA	24.5
Complications in mother after birth of child	37	4.2	NA	4.2
Illness in newborn/sick newborn	34	1.4	1.8	0.9
Accidental injury, road traffic accidents and falls	498	52.2	68.6	34.6
Accidental drowning and submersion	18	2.2	3.8	0.6
Burns and corrosions	32	3.3	1.8	4.9

Poisoning	6	0.5	0.7	0.3
Intentional self-harm	1	0.0	0.0	0.0
Assault	6	0.2	0.2	0.1
Contact with venomous/harm-causing animals and plants	12	2.3	2.4	2.1
Symptoms not fitting into any of the above categories	488	75.3	48.3	104.2
Could not even state the main symptom"	19	1.0	0.3	1.7
Total	30936			

Source: National Statistical Office, Government of India, 2019 (for types of ailments)

Notes: Computed from the unit level data of NSS Round 75; [1]Prevalence has been computed using sample weights; NA = Not applicable

Table 2.7: Incidence rates of various ailments in India, 2017-18

Ailment types	Incidence cases (Sample, unweighted)[a]	Incidence per 100,000[1]		
		Total	Male	Female
"Fever with consciousness or altered consciousness	746	187.1	175.7	199.4
Malaria	195	45.1	53.6	36.0
Fever due to diphtheria, whooping cough	725	120.2	118.0	122.6
All other fevers, including typhoid, fever with rash/eruptive lesions and fevers of unknown origin	6210	1509.3	1449.9	1573.0
Tuberculosis	38	6.5	10.7	2.0
Filariasis	1	1.0	0.0	2.1
Tetanus	4	1.7	0.2	3.3
HIV/AIDS	0	0.0	0.0	0.0
Other sexually transmitted diseases	3	1.1	1.6	0.6
Jaundice	54	5.3	3.9	6.9
Diarrhoeas/dysentery/increased frequency of stools	462	97.9	86.7	109.8
Worms infestations	21	4.3	3.4	5.2
Cancers and occurrence of any growing painless lump in the body	10	0.2	0.1	0.3

Anaemia	43	17.4	12.8	22.4
Bleeding disorders	17	1.7	2.5	0.8
Diabetes	44	8.5	7.1	10.1
Under-nutrition	10	3.5	4.9	1.9
Goitre and other diseases of thyroid	10	1.6	1.8	1.4
Other metabolic disorders, including obesity	7	2.4	0.2	4.7
Mental retardation	1	0.0	0.0	0.1
Mental disorders	4	0.1	0.0	0.1
Headache	247	49.4	42.7	56.6
Seizures or unknown epilepsy	3	0.1	0.0	0.3
Weakness in limb muscles and difficulty in movements	49	13.9	6.6	21.8
Stroke/hemiplegia/sudden onset weakness in half of body or loss of speech	32	2.1	1.8	2.2
Others including memory loss, confusion	6	0.4	0.7	0.2
Discomfort/pain in the eye with redness or swellings//boils	95	27.4	21.8	33.4
Cataract	10	0.7	1.2	0.1
Glaucoma	0	0.0	0.0	0.0
Decreased vision (chronic, not possible to correct with glasses)	6	0.5	0.2	0.9
Eye problem: Others (Strabismus, nystagmus, ptosis and adnexa)	11	1.5	2.5	0.5
Earache with discharge/bleeding from ear/infections	70	13.1	10.8	15.5
Decreased/loss of hearing	4	0.2	0.1	0.3
Hypertension	64	19.5	18.0	21.2
Heart disease: Chest pain, breathlessness	103	19.6	21.5	17.5
Acute upper respiratory infections	2021	385.9	326.6	449.3
Cough with sputum with or without fever but not TB	399	90.7	66.1	117.0
Bronchial asthma/recurrent episode of wheezing and breathlessness	43	8.0	4.6	11.7
Diseases of mouth, teeth, gums	89	19.6	12.9	26.7
Pain in abdomen: Gastric and peptic ulcers/ acid reflux	397	104.2	71.5	139.2
Lump or fluid in abdomen or scrotum	21	1.9	1.7	2.2
Gastrointestinal bleeding	12	0.7	0.3	1.1
Skin infection (boil, abscess, itching) and other skin diseases	227	54.2	56.9	51.2
Joint or bone disease/pain or swelling in any of the joints	257	64.5	54.2	75.4

Back or body aches	182	39.3	29.9	49.4
Any difficulty or abnormality in urination	54	6.7	8.2	5.1
Pain in pelvic region/RTI/Pain in the male genital area	16	2.4	1.2	3.6
Change/irregularity in menstrual cycle or excessive bleeding/pain during menstruation and any other gynaecological and andrological disorders, including male/female infertility	35	8.3	0.1	17.1
Pregnancy with complications before or during labour (abortion, ectopic pregnancy, hypertension)	19	5.4	NA	NA
Complications in mother after birth of child	10	0.6	NA	NA
Illness in newborn/sick newborn	40	2.1	2.7	1.4
Accidental injury, road traffic accidents and falls	252	38.9	60.6	15.7
Accidental drowning and submersion	8	1.6	2.9	0.1
Burns and corrosions	23	3.0	2.1	3.9
Poisoning	6	0.6	0.2	1.0
Intentional self-harm	0	0.0	0.0	0.0
Assault	2	0.0	0.1	0.0
Contact with venomous/harm-causing animals and plants	11	2.5	2.9	2.1
Symptoms not fitting into any of the above categories	104	20.6	11.2	30.6
Could not even state the main symptom"	6	0.6	0.8	0.5
Total	13539			

Source: National Statistical Office, Government of India, 2019 (for types of ailments)

Notes: Computed from the unit level data of NSS Round 75; [1]Incidence rates have been computed using sample weights; NA = Not applicable

As the reported ailment types are not the same in the 60th and the 75th round of NSS, comparison between disease-specific prevalence and incidence rates of these two rounds are possible only for some diseases/diagnoses. Table 2.8 presents a comparative analysis of prevalence and incidence rates of selective diseases in 2004 and 2017-18.

Table 2.8: Prevalence and incidence rates of selected ailments in India, 2004 and 2017-18

Ailment types	Prevalence per 100,000		Incidence per 100,000	
	2004	2017-18	2004	2017-18
Diarrhoea/dysentery	127.6	17.9	382.8	97.9
Worm infestation	16.4	5.4	28.4	4.3
Tuberculosis	108.6	32.8	6.0	6.5
Tetanus	2.3	0.1	1.4	1.7
Jaundice	30.9	11.1	14.2	5.3
Diseases of mouth/teeth/gum	54.4	19.9	60.9	19.6
Cancer and other tumours	47.1	25.9	8.1	0.2
Diabetes	333.1	1000.6	15.6	8.5
Hypertension	463.3	1060.7	51.7	19.5
Heart Disease	244.0	237.2	19.4	19.6
Bronchial asthma	300.1	209.9	61.6	8.0
Disorders of joints and bones	570.7	457.8	91.3	64.5
Cataract	143.1	12.2	6.2	0.7
Glaucoma	23.7	5.6	2.7	0.0
Mental/psychiatric disorder	62.0	39.0	5.8	0.1
Anaemia	35.7	38.9	9.3	17.4

Note: Computed from the unit level data of NSS Round 60 and Round 75

From the above table (Table 2.8), we find that for some reported ailments/diagnoses, both the prevalence and incidence rates declined considerably (around one third) between 2004 and 2017-18, namely, diarrhoea/dysentery, worm infestation, jaundice, cataract, glaucoma and diseases of mouth/teeth/gum. Besides, in tuberculosis and tetanus, a significantly lower prevalence was observed in 2017-18. In the case of cancer and other tumours, bronchial asthma and mental/psychiatric disorder, the incidence rate decreased considerably. In contrast, the prevalence of diabetes increased by three times and the prevalence of hypertension increased by 2.3 times between 2004 and 2017-18. Also, both prevalence and incidence rates of anaemia increased during this period.

2.3.3. Computation of average duration of illness using the life table method

One crucial variable for measuring YLD is the "average duration of disability". In the NSSO report No. 507, the average duration of ailments by broad ailment types is available (Appendix A, A-160 to A-165). In the report, the duration of illness was calculated incorporating the value '999', which depicts the case where the period of ailments has not been specified. Table 39, Appendix A, A-165, part of which has been reproduced in Table 2.3, clearly underlines this fact. Besides, we have already highlighted that among those who reported their ailment status as 1 (started more than 15 days ago and is continuing), some also said their illness duration was 15 days or less. Also, how can the average duration of ailments be more than 15 days for those who reported the onset of ailments within 15 days before the survey date? Therefore, we should not use the average duration of illness of the NSS report.

However, the average duration of ailment can be computed following the life table technique as given by Lee (1993). The life table model of Lee is based on both complete data (e.g. the number of deaths) and incomplete data (e.g. the number of patients lost to follow-up). In the present analysis, the duration of an ailment that ended during the period of 15 days (whether it started more than 15 days ago or within 15 days) is a complete observation and the duration of an ailment continuing on the survey date is a censored observation. With the help of the above information, the average duration of each disease/condition can be calculated.

The column headings of the life table are given below:

1. Duration (t_i - t_{i+1}): The first column gives the duration/interval into which the censored or complete observations are distributed. i = 0, 1, 2, 3,…, n. The last interval is open.
2. Midpoint (m_i): Midpoint of the time period is calculated as $(t_i + t_{i+1})/2$.
3. Width (w_i): The width of each duration is ($t_{i+1} - t_i$), and for the last interval, it is $t_k = \infty$.
4. Total observations (O_i): It indicates the number of persons reporting ailment with duration at the i^{th} interval.
5. Censored observation (E_i): Number of persons who reported that their ailment was continuing at the i^{th} interval. It is calculated by adding persons with status 1 and status 3. In Lee's life table survival analysis, this is similar to "the number of individuals who are lost to observation and whose survival status is thus unknown in the i^{th} interval" (Lee, 1993, p. 26 of Chapter 21).
6. Complete observation (F_i): Number of persons who reported that their ailment had ended at the i^{th} interval. It is calculated by adding persons with status 2 and status 4. In Lee's survival analysis, this is analogous to the population dying in the i^{th} interval.

7. Number entering the ith interval (G_i): “The number of individuals entering the first interval is the total sample size” (Lee, 2003, p. 26 of Chapter 21). Other entries are determined as $G_{i+1} = (G_i – E_i – F_i)$.
8. Number exposed to risk (H_i): The number of individuals exposed to risk in the ith interval. It is assumed that individuals continuing in the interval are exposed to the risk of ending for one-half the interval. $H_i= G_i – (E_i/2)$.
9. Conditional proportion ending: The conditional probability of ending illness in the ith interval and is estimated as F_i/H_i.
10. Conditional proportion continuing (P_i) = $1 – (F_i/H_i)$. Similar as conditional proportion surviving.
11. Cumulative proportion continuing (C_i): It is similar to cumulative survival rate, and the radix is 1. Other entries are determined as $C_{i+1} = (C_i * P_i)$.
12. C*w: As interval is not equal, it is necessary to multiply C (cumulative proportion continuing) with w (width). ∑ C*w gives the average duration of illness. If we want to estimate the average duration of illness taking the cut off as 15 days, then following the rule of trapezium, the formula will be written as:

$$0.5* (C_0 + C_{15}) + \sum_{i=1}^{i=14} C*w$$

Table 2.9 shows the computation of the average duration of ailment for diarrhoea/dysentery using the data of NSS, Round 60. Similarly, we have estimated the average duration of other illnesses for 2004.

In the report, NSS KI 75/25.0, the disease-specific average duration of ailment has not been provided. However, in our analysis of the 75th round of NSS data, we already observed that the “status of ailment” did not match with the “duration of ailment” for most of the reported diagnoses. Therefore, using the life table technique of Lee, we have calculated the disease-specific average duration of ailment for the year 2017-18. Table 2.10 shows the computation of the average duration of ailment for diarrhoea/dysentery/increased frequency of stools using the data of NSS, Round 75.

One of the major drawbacks of the NSS data is the reported duration of ailments. They are found to be very long for a few observations, which led to an increase in the value of ∑C*w to an enormous extent. On the other hand, there is no exact limit up to which the duration should be considered. It can only be taken arbitrarily, and the average duration of ailment will differ for the same disease with truncation at 365 days, 180 days and 30 days.

The average duration for diarrhoea/dysentery truncated at 15 days, 30 days, 180 days, and 365 days was estimated at 7.2, 9.6, 28.5 and 51.3, in 2004 (based on NSS, round 60) and 5.6, 7.2, 26.4 and 57.7, respectively in 2017-18 (based on NSS, round 75). It clearly depicts that the average duration of ailment declined between 2004 and 2017-18 if the average truncated duration is taken as six months or less. If the cut off duration is conceived as one year, we observe a higher average duration of ailment in 2017-18. In fact, in 2004, the highest duration of ailment for diarrhoea/dysentery was reported as 700 days, whereas the reported duration was as high as 3650 days in 2017-18. There were four observations where the duration of diarrhoea/dysentery was reported more than 1500 days in 2017-18. As a result, the life table duration of diarrhoea/dysentery was found 70.99 days in 2004 and 353.21 days in 2017-18. The highest reported duration of other ailments was also found much higher in the 75th round than in the 60th round.

The average truncated duration of ailment for heart disease (continues for very long times) and tetanus (continues for short duration) of the 60th round has been shown in Appendices 2.2 and 2.3, respectively. Estimating the average duration of ailment by the life table method reveals an important shortcoming of the NSS data. It indicates that the life table duration of illness has been considerably amplified by the reporting and recording of a few cases with long-duration.

2.3.4. Consistency between estimated life table duration and implied duration through a mathematical relationship

A mathematical relationship exists among incidence, prevalence and duration of ailment. Suppose the incidence rate of a disease in a population is approximately constant, and the duration of the disease also remains stable. In that case, the prevalence is the product of incidence and duration (Young, 2005). It can be expressed as: $P = I*D$ or, $D = P/I$

where P = Prevalence, I = Incidence rate and D = Duration of disease/condition

Though there is seasonal variability in the incidence rate for some ailments, we assume there should not be a very high difference between estimated life table duration and implied duration derived by P/I. From Table 2.11, we find that compared to the implied duration (P/I), the life table duration for each ailment is markedly high.

Table 2.9: Computation of average duration of ailment from diarrhoea/dysentery using the life table method based on NSS data, Round 60, 2004

Duration (days)	Midpoint	Width	Total	(Contd.) Censored 1+3	(ended) Complete 2+4	No entering interval	No exposed to risk	Conditional Proportion Ending	Conditional proportion surviving (P)	Cumulative proportion surviving (C)	
T		w		E	F	G	G - E/2 = H	F/H	1- F/H = P	Ci+1 = Ci*P	C*w
0	0.5	1	0	0	0	4492248	4492248.0	0.00000	1.00000	1.00000	1.00000
1	1.5	1	127600	27857	99743	4492248	4478319.5	0.02227	0.97773	1.00000	1.00000
2	2.5	1	667198	143555	523643	4364648	4292870.5	0.12198	0.87802	0.97773	0.97773
3	3.5	1	879657	123536	756121	3697450	3635682.0	0.20797	0.79203	0.85846	0.85846
4	4.5	1	622837	105153	517684	2817793	2765216.5	0.18721	0.81279	0.67993	0.67993
5	5.5	1	598607	127959	470648	2194956	2130976.5	0.22086	0.77914	0.55264	0.55264
6	6.5	1	293185	55361	237824	1596349	1568668.5	0.15161	0.84839	0.43058	0.43058
7	7.5	1	249062	84656	164406	1303164	1260836.0	0.13039	0.86961	0.36530	0.36530
8	8.5	1	180211	42223	137988	1054102	1032990.5	0.13358	0.86642	0.31767	0.31767
9	9.5	1	24732	10459	14273	873891	868661.5	0.01643	0.98357	0.27523	0.27523
10	10.5	1	242278	118716	123562	849159	789801.0	0.15645	0.84355	0.27071	0.27071
11	11.5	1	30287	847	29440	606881	606457.5	0.04854	0.95146	0.22836	0.22836
12	12.5	1	45400	29565	15835	576594	561811.5	0.02819	0.97181	0.21727	0.21727
13	13.5	1	3040	0	3040	531194	531194.0	0.00572	0.99428	0.21115	0.21115
14	14.5	1	45128	3158	41970	528154	526575.0	0.07970	0.92030	0.20994	0.20994
15	15.5	1	170573	80565	90008	483026	442743.5	0.20330	0.79670	0.19321	0.19321
16	16.5	1	10653	8395	2258	312453	308255.5	0.00733	0.99267	0.15393	0.15393
17	17.5	1	20124	19578	546	301800	292011.0	0.00187	0.99813	0.15280	0.15280
18	19.0	2	21482	20831	651	281676	271260.5	0.00240	0.99760	0.15252	0.30503
20	20.5	1	66509	36006	30503	260194	242191.0	0.12595	0.87405	0.15215	0.15215
21	21.5	1	8303	8303	0	193685	189533.5	0.00000	1.00000	0.13299	0.13299

22	22.5	1	3009	3009	0	185382	183877.5	0.00000	1.00000	0.13299	0.13299
23	23.5	1	156	0	156	182373	182373.0	0.00086	0.99914	0.13299	0.13299
24	24.5	1	242	242	0	182217	182096.0	0.00000	1.00000	0.13287	0.13287
25	26.5	3	8027	7949	78	181975	178000.5	0.00044	0.99956	0.13287	0.39862
28	29.0	2	463	463	0	173948	173716.5	0.00000	1.00000	0.13282	0.26563
30	32.5	5	46894	26047	20847	173485	160461.5	0.12992	0.87008	0.13282	0.66408
35	37.0	4	3553	590	2963	126591	126296.0	0.02346	0.97654	0.11556	0.46224
39	39.5	1	1811	602	1209	123038	122737.0	0.00985	0.99015	0.11285	0.11285
40	42.5	5	6695	6600	95	121227	117927.0	0.00081	0.99919	0.11174	0.55869
45	46.5	3	29684	23223	6461	114532	102920.5	0.06278	0.93722	0.11165	0.33494
48	49.0	2	2883	2883	0	84848	83406.5	0.00000	1.00000	0.10464	0.20928
50	55.0	10	54	54	0	81965	81938.0	0.00000	1.00000	0.10464	1.04639
60	62.5	5	27858	26381	1477	81911	68720.5	0.02149	0.97851	0.10464	0.52319
65	72.5	15	4265	4265	0	54053	51920.5	0.00000	1.00000	0.10239	1.53585
80	85.0	10	421	421	0	49788	49577.5	0.00000	1.00000	0.10239	1.02390
90	95.0	10	301	301	0	49367	49216.5	0.00000	1.00000	0.10239	1.02390
100	102.5	5	10514	10514	0	49066	43809.0	0.00000	1.00000	0.10239	0.51195
105	125.5	41	809	809	0	38552	38147.5	0.00000	1.00000	0.10239	4.19798
146	148.0	4	2432	2432	0	37743	36527.0	0.00000	1.00000	0.10239	0.40956
150	175.0	50	10201	10201	0	35311	30210.5	0.00000	1.00000	0.10239	5.11949
180	195.0	30	10201	10201	0	27885	22784.5	0.00000	1.00000	0.10239	3.07170
200	220.0	40	7426	7426	0	25110	21397.0	0.00000	1.00000	0.10239	4.09559
210	225.0	30	985	985	0	17684	17191.5	0.00000	1.00000	0.10239	3.07170
240	245.0	10	2690	2690	0	16699	15354.0	0.00000	1.00000	0.10239	1.02390
250	255.0	10	2284	2284	0	14009	12867.0	0.00000	1.00000	0.10239	1.02390
260	265.0	10	2164	2164	0	11725	10643.0	0.00000	1.00000	0.10239	1.02390
270	285.0	30	2513	2513	0	9561	8304.5	0.00000	1.00000	0.10239	3.07170
300	316.5	33	1420	1420	0	7048	6338.0	0.00000	1.00000	0.10239	3.37886
333	349.0	32	162	162	0	5628	5547.0	0.00000	1.00000	0.10239	3.27647
365	377.5	25	2957	736	2221	5466	5098.0	0.43566	0.56434	0.10239	2.55975

390	445.0	110	356	356	0	2509	2331.0	0.00000	1.00000	0.05778	6.35608
500	523.5	47	1097	1097	0	2153	1604.5	0.00000	1.00000	0.05778	2.71578
547	623.5	153	673	673	0	1056	719.5	0.00000	1.00000	0.05778	8.84073
700			383	383	0	383	191.5	0.00000	1.00000	0.05778	
			4492248								70.99254

Source: Computed from the unit level data of NSS, Round 60, 2004

Notes: Sample weight has been applied

When the duration is truncated at 15 days, 30 days, 180 days and 365 days, the average duration of illness (in days) has been estimated as 7.2, 9.6, 28.5 and 51.3, respectively.

Table 2.10: Computation of average duration of ailment from diarrhoea/dysentery/increased frequency of stools using the life table method based on NSS data, Round 75, 2017-18

Duration (days)	Midpoint	Width	Total	(Contd.) Censored	(ended) Complete	Number entering interval	Number exposed to risk	Conditional Proportion Ending	Conditional proportion surviving (P)	Cumulative proportion surviving (C)	
				1+3	2+4						
t	m	w	O	E	F	G	G - E/2 = H	F/H	1- F/H = P	Ci+1 = Ci*P	C*w
0	0.5	1	0	0	0	1433299	1433299.0	0.00000	1.00000	1.00000	1.00000
1	1.5	1	70936	1361	69575	1433299	1432845.3	0.04856	0.95144	1.00000	1.00000
2	2.5	1	287136	2873	284263	1362363	1361405.3	0.20880	0.79120	0.95144	0.95144
3	3.5	1	327701	47029	280672	1075227	1059550.7	0.26490	0.73510	0.75278	0.75278
4	4.5	1	220405	7559	212846	747526	745006.3	0.28570	0.71430	0.55337	0.55337
5	5.5	1	211970	12116	199854	527121	523082.3	0.38207	0.61793	0.39527	0.39527
6	6.5	1	37854	3709	34145	315151	313914.7	0.10877	0.89123	0.24425	0.24425

7	7.5	1	55349	3845	51504	277297	276015.3	0.18660	0.81340	0.21768	0.21768
8	8.5	1	31831	2627	29204	221948	221072.3	0.13210	0.86790	0.17706	0.17706
9	9.5	1	11771	1099	10672	190117	189750.7	0.05624	0.94376	0.15367	0.15367
10	10.5	1	27189	11082	16107	178346	174652.0	0.09222	0.90778	0.14503	0.14503
11	11.5	1	17088	0	17088	151157	151157.0	0.11305	0.88695	0.13166	0.13166
12	12.5	1	4936	1727	3209	134069	133493.3	0.02404	0.97596	0.11677	0.11677
13	13.5	1	5434	4369	1065	129133	127676.7	0.00834	0.99166	0.11397	0.11397
14	14.5	1	320	0	320	123699	123699.0	0.00259	0.99741	0.11301	0.11301
15	15.5	1	24791	6848	17943	123379	121096.3	0.14817	0.85183	0.11272	0.11272
16	17.0	2	5860	5860	0	98588	96634.7	0.00000	1.00000	0.09602	0.19204
18	19.0	2	4931	4931	0	92728	91084.3	0.00000	1.00000	0.09602	0.19204
20	22.5	5	3614	3614	0	87797	86592.3	0.00000	1.00000	0.09602	0.48010
25	26.0	2	1900	1442	458	84183	83702.3	0.00547	0.99453	0.09602	0.19204
27	28.5	3	1146	1146	0	82283	81901.0	0.00000	1.00000	0.09549	0.28648
30	32.0	4	6755	6755	0	81137	78885.3	0.00000	1.00000	0.09549	0.38198
34	34.5	1	31984	31984	0	74382	63720.7	0.00000	1.00000	0.09549	0.09549
35	40.0	10	17504	17504	0	42398	36563.3	0.00000	1.00000	0.09549	0.95495
45	47.5	5	75	75	0	24894	24869.0	0.00000	1.00000	0.09549	0.47747
50	51.0	2	697	697	0	24819	24586.7	0.00000	1.00000	0.09549	0.19099
52	56.0	8	295	295	0	24122	24023.7	0.00000	1.00000	0.09549	0.76396
60	67.5	15	708	708	0	23827	23591.0	0.00000	1.00000	0.09549	1.43242
75	76.0	2	360	360	0	23119	22999.0	0.00000	1.00000	0.09549	0.19099
77	78.5	3	462	462	0	22759	22605.0	0.00000	1.00000	0.09549	0.28648
80	85.0	10	156	156	0	22297	22245.0	0.00000	1.00000	0.09549	0.95495
90	145.0	110	1274	1274	0	22141	21716.3	0.00000	1.00000	0.09549	10.50444
200	222.0	44	6769	6769	0	20867	18610.7	0.00000	1.00000	0.09549	4.20178
244	272.0	56	301	301	0	14098	13997.7	0.00000	1.00000	0.09549	5.34771
300	333.0	66	717	717	0	13797	13558.0	0.00000	1.00000	0.09549	6.30266
366	493.0	254	2820	2820	0	13080	12140.0	0.00000	1.00000	0.09549	24.25570
620	675.0	110.0	8014	8014	0	10260	7588.7	0.00000	1.00000	0.09549	10.50444

730	1225.0	990.0	174	174	0	2246	2188.0	0.00000	1.00000	0.09549	94.53995
1720	1965.0	490.0	142	142	0	2072	2024.7	0.00000	1.00000	0.09549	46.79250
2210	2645.0	870.0	301	301	0	1930	1829.7	0.00000	1.00000	0.09549	83.08056
3080	3365.0	570.0	897	897	0	1629	1330.0	0.00000	1.00000	0.09549	54.43209
3650			732	732	0	732	488.0	0.00000	1.00000	0.09549	0.00000
			1433299								353.21295

Source: Computed from the unit level data of NSS, Round 75, 2017-18

Notes: Sample weight has been applied

When the duration is truncated at 15 days, 30 days, 180 days and 365 days, the average duration of illness (in days) has been estimated as 5.6, 7.2, 26.4 and 57.7, respectively.

Table 2.11: Difference in the duration of illness computed by two different procedures based on NSS data, Round 60, 2004

Ailment types	Incidence rate per 1000 per year (I)	Prevalence per 1000 (P)	D=P/I	Life table estimate of duration in days	Life table estimate of duration in years (LTED)	Difference between LTED &P/I	Proportion who reported status but not duration (%)
Diarrhoea/ Dysentery	93.1	1.3	0.01370	64.8	0.17767	0.16397	0.5
Amoebiosis	5.2	0.2	0.03836	228.0	0.62475	0.58639	0.8
Worm Infection	6.9	0.2	0.02369	194.8	0.53366	0.50997	0.0
Gastritis/ Gastric/ peptic ulcer	29.2	2.5	0.08468	612.5	1.67805	1.59337	0.1
Hepatitis/ Jaundice	3.4	0.3	0.08965	587.1	1.60848	1.51883	0.0
Disorders of joints and bones	22.2	5.7	0.25685	858.3	2.35143	2.09458	0.3
Bronchial Asthma	15.0	3.0	0.20013	769.6	2.10843	1.90830	0.5
Respiratory disease including ear/	108.3	3.4	0.03173	325.9	0.89295	0.86123	0.1

nose/ throat ailment							
Fever of unknown origin	362.1	5.3	0.01477	79.1	0.21660	0.20182	0.4
Tuberculosis	1.5	1.1	0.74180	932.2	2.55398	1.81218	0.5
Hypertension	12.6	4.6	0.36799	882.7	2.41827	2.05028	0.0
Heart disease	4.7	2.4	0.51708	910.6	2.49477	1.97769	0.6
Diseases of kidney/ urinary system	4.6	0.8	0.17459	798.1	2.18649	2.01190	0.9
Psychiatric disorders	1.4	0.6	0.44194	903.8	2.47608	2.03414	0.7
Neurological disorders	8.8	1.7	0.19754	796.1	2.18120	1.98366	0.3
Diabetes mellitus	3.8	3.3	0.87735	962.1	2.63595	1.75860	0.3
Malaria	29.1	0.6	0.01949	20.5	0.05620	0.03671	0.2
Gynaecological disorders	15.5	1.7	0.11277	663.8	1.81864	1.70587	0.1
Prostatic disorders	0.7	0.1	0.19800	758.1	2.07701	1.87901	0.0
Cataract	1.5	1.4	0.94874	916.9	2.51219	1.56345	0.9
Conjunctivitis	4.5	0.3	0.06292	458.2	1.25531	1.19238	0.0
Glaucoma	0.7	0.2	0.35756	743.0	2.03570	1.67814	0.0
Sexually transmitted diseases	0.3	0.0	0.18326	542.6	1.48668	1.30342	0.0
Goitre	0.3	0.1	0.28598	713.1	1.95366	1.66768	0.0
Anaemia	2.3	0.4	0.15727	656.1	1.79756	1.64029	0.0
Under-nutrition	0.4	0.1	0.25603	387.1	1.06058	0.80455	0.0
Filariasis/ Elephantiasis	0.2	0.1	0.62075	818.1	2.24148	1.62073	7.2
Whooping cough	40.3	1.1	0.02655	301.9	0.82708	0.80053	0.1
Diseases of skin	16.5	1.8	0.11135	716.4	1.96267	1.85132	0.1
Diptheria	2.6	0.0	0.01748	44.0	0.12057	0.10309	0.4
Tetanus	0.3	0.0	0.06868	149.2	0.40869	0.34002	0.0
Mumps	4.4	0.1	0.02882	93.2	0.25523	0.22641	0.0
Eruptive	8.4	0.2	0.02595	41.1	0.11262	0.08667	0.0
Cancer and other tumours	2.0	0.5	0.23948	893.2	2.44723	2.20776	1.0
Diseases of mouth/ teeth/ gum	14.8	0.5	0.03667	393.7	1.07875	1.04208	1.6
Visual disability (excluding	2.1	1.0	0.47417	937.3	2.56799	2.09382	0.2

cataract)							
Locomotor disability	4.4	1.7	0.38072	885.7	2.42649	2.04577	1.2
Hearing disability	2.7	0.9	0.31588	814.4	2.23134	1.91545	0.6
Speech disability	0.2	0.3	1.09834	847.5	2.32181	1.22347	5.3
Accidents/injuries/burns/ fractures/poisoning	33.9	1.9	0.05628	569.5	1.56028	1.50401	0.0
Other undiagnosed ailments	27.7	1.7	0.06141	583.1	1.59748	1.53607	0.9
Other diagnosed ailments	176.9	7.8	0.04434	451.9	1.23812	1.19378	0.2

Source: Computed from the unit level data of NSS, Round 60, 2004
Note: Computation was done using sample weights

Table 2.12: Difference in the duration of illness computed by two different procedures based on NSS data, Round 75, 2017-18

Ailment type	incidence rate per 1000 per year (I)	Prevalence per 1000 (P)	D=P/I	Life table estimate of duration in days	Life table estimate of duration in years (LTED)	Difference between LTED and P/I
Fever with consciousness or altered consciousness	45.5	0.5	0.01034	1153.7	3.16085	3.15051
Malaria	11.0	0.2	0.01951	162.8	0.44604	0.42652
Fever due to diphtheria, whooping cough	29.3	0.4	0.01199	355.5	0.97398	0.96199
All other fevers including typhoid, fever with rash/eruptive lesions and fevers of unknown origin	367.3	3.2	0.00883	381.7	1.04581	1.03698
Tuberculosis	1.6	0.3	0.20887	9262.3	25.37618	25.16731

Filariasis	0.2	0.0	0.13118	8341.5	22.85353	22.72235
Tetanus	0.4	0.0	0.00227	183.8	0.50369	0.50143
HIV/AIDS	0.0	0.0	-	4370.0	11.97260	-
Other sexually transmitted diseases	0.3	0.0	0.04565	2896.6	7.93577	7.89012
Jaundice	1.3	0.1	0.08551	3552.9	9.73392	9.64841
Diarrhoeas/dysentery/increased frequency of stools	23.8	0.2	0.00752	385.8	1.05689	1.04937
Worms infestations	1.0	0.1	0.05192	3285.4	9.00119	8.94926
Cancers and occurrence of any growing painless lump in the body	0.1	0.3	4.73733	14695.0	40.26020	35.52286
Anaemia	4.2	0.4	0.09194	11864.7	32.50596	32.41402
Bleeding disorders	0.4	0.1	0.27561	7558.4	20.70781	20.43220
Diabetes	2.1	10.0	4.81027	18862.8	51.67901	46.86874
Under-nutrition	0.8	0.1	0.07306	4240.2	11.61696	11.54390
Goitre and other diseases of thyroid	0.4	1.5	3.77847	14549.1	39.86043	36.08196
Others (including obesity)	0.6	0.2	0.43272	6536.5	17.90809	17.47537
Mental retardation	0.0	0.2	17.94048	14466.6	39.63448	21.69400
Mental disorders	0.0	0.4	22.13036	18060.0	49.47945	27.34909
Headache	12.0	0.6	0.05181	7800.8	21.37199	21.32017
Seizures or unknown epilepsy	0.0	0.2	6.06710	14409.2	39.47716	33.41006
Weakness in limb muscles and difficulty in movements	3.4	0.7	0.21844	8297.1	22.73180	22.51336
Stroke/hemiplegia/sudden onset weakness in half of body or loss of speech	0.5	0.5	0.97269	13505.0	36.99988	36.02720
Others including memory loss, confusion	0.1	0.2	1.55715	15858.6	43.44825	41.89110
Discomfort/pain in the eye with redness or swellings//boils	6.7	0.2	0.03451	2514.1	6.88803	6.85352
Cataract	0.2	0.1	0.72516	8391.4	22.99006	22.26489
Glaucoma	0.0	0.1	-	16399.8	44.93101	-
Decreased vision (chronic, not possible to	0.1	0.1	0.68939	10956.7	30.01842	29.32903

correct with glasses)						
Eye problem: Others (Strabismus, nystagmus, ptosis and adnexa)	0.4	0.1	0.31381	4863.0	13.32328	13.00947
Earache with discharge/bleeding from ear/infections	3.2	0.1	0.02990	4471.2	12.24978	12.21988
Decreased/loss of hearing	0.0	0.1	2.71302	17963.0	49.21362	46.50060
Hypertension	4.8	10.6	2.23126	19577.8	53.63786	51.40660
Heart disease: Chest pain, breathlessness	4.8	2.4	0.49646	13498.8	36.98291	36.48645
Acute upper respiratory infections	93.9	1.6	0.01692	2126.7	5.82669	5.80976
Cough with sputum with or without fever but not TB	22.1	0.4	0.01971	3080.0	8.43826	8.41855
Bronchial asthma/recurrent episode of wheezing and breathlessness	2.0	2.1	1.07388	21362.1	58.52618	57.45229
Diseases of mouth, teeth, gums	4.8	0.2	0.04169	2542.0	6.96435	6.92266
Pain in abdomen: Gastric and peptic ulcers/ acid reflux	25.4	1.8	0.07157	9731.4	26.66134	26.58977
Lump or fluid in abdomen or scrotum	0.5	0.3	0.57008	10519.6	28.82085	28.25077
Gastrointestinal bleeding	0.2	0.1	0.59958	10411.2	28.52379	27.92421
Skin infection (boil, abscess, itching) and other skin disease	13.2	1.4	0.10877	8403.8	23.02399	22.91522
Joint or bone disease/pain or swelling in any of the joints	15.7	4.6	0.29184	13139.4	35.99827	35.70643
Back or body aches	9.6	1.3	0.13952	18484.1	50.64147	50.50195
Any difficulty or abnormality in urination	1.6	0.4	0.24286	6766.2	18.53748	18.29462
Pain in pelvic region/RTI/Pain in male genital area	0.6	0.2	0.30228	5269.2	14.43612	14.13385
Change/irregularity in menstrual cycle or excessive bleeding/pain during menstruation and any other gynaecological and andrological disorders including male/female infertility	2.0	0.3	0.13091	11386.9	31.19697	31.06606

Pregnancy with complications before or during labour (abortion, ectopic pregnancy, hypertension)	0.6	0.1	0.18642	344.2	0.94294	0.75652
Complications in mother after birth of child	0.1	0.0	0.28070	428.7	1.17448	0.89378
Illness in newborn/sick newborn	0.5	0.0	0.02731	393.2	1.07708	1.04977
Accidental injury, road traffic accidents and falls	9.5	0.5	0.05516	2935.3	8.04205	7.98688
Accidental drowning and submersion	0.4	0.0	0.05902	357.0	0.97801	0.91898
Burns and corrosions	0.7	0.0	0.04542	1810.6	4.96058	4.91517
Poisoning	0.1	0.0	0.03309	2177.3	5.96509	5.93200
Intentional self-harm	0.0	0.0	-	60.0	0.16438	-
Assault	0.0	0.0	0.15800	1460.0	4.00000	3.84200
Contact with venomous/harm-causing animals and plants	0.6	0.0	0.03736	61.8	0.16937	0.13201
Symptom not fitting into any of above categories	5.0	0.8	0.15034	11973.9	32.80518	32.65484
Could not even state the main symptom	0.2	0.0	0.06509	2493.1	6.83052	6.76543

Source: Computed from the unit level data of NSS, Round 75, 2017-18
Note: Computation was done using sample weights

Therefore, the difference in the duration of illness calculated by these two procedures is enormous. The differences are extremely large for long-duration ailments such as heart disease, hypertension, neurological disorders, bronchial asthma, locomotor disability etc. It is also evident from Table 2.12 (based on data of NSS, Round 75) that for each reported diagnosis/symptom, the difference between life table duration and implied duration is exorbitantly high due to the very high life table duration of ailments.

2.4. Conclusion

The results of our analysis reveal that the total duration of ailments has not been correctly reported in both the 60th and the 75th round of the National Sample Survey. It is one of the fundamental problems with health data in developing countries, where the percentage of people with elementary education is substantially low. In most cases, the "status of ailment" did not match with the "duration of ailment". The reported length of illness (in days) was extremely high for many diseases/conditions. The discrepancy between the reported "status of ailment" and the "duration of ailment" was lower in the 75th round compared to the 60th round of NSS, but the duration of various diseases/conditions reported in the 75th round was considerably higher than the 60th round. Our life table estimates of the duration of ailments, using both the 60th and the 75th round of NSS data, show significant variation when compared with the implied duration derived by P/I (Table 2.11 and Table 2.12). Based on the data quality evaluation, we can say that the average duration of ailments in the NSS report (No. 507) have serious flaws and should not be used. Our findings indicate that the reporting of duration was done very casually. Also, there is a chance of recall lapse. On the other hand, there is no question of recall lapse in the case of prevalence. Therefore, it can be said that a greater confidence level is attached to the prevalence approach compared to the incidence approach. In this situation, the prevalence approach appears more suitable for determining YLD than the incidence approach (which needs information on the average duration of ailment) using the NSS data.

Chapter 3

Estimation of Years Lost due to Disability (YLD) and Years of Life Lost due to Premature Mortality (YLL) in India, 2004

3.1. Introduction

How can the burden of morbidity in a population be expressed? Since the publication of the Global Burden of Disease Study (GBDS) in 1996, which elaborately provided the concept of Years Lost due to Disability (YLD), quantifying morbidity in terms of YLD has become very popular. One of our main objectives in this chapter is to estimate disease-specific YLD for India's male and female population using the NSS data. To the best of our knowledge, no previous studies estimated YLD in India using the NSS data.

From our assessment of the NSS data in the previous chapter, we concluded that, given the poor quality of the NSS data on the duration of ailment, it would be wise to adopt the prevalence approach to estimate YLD from those datasets. Therefore, we used the prevalence approach in our study to estimate YLD. In the manual of National Burden of Disease Studies published by the World Health Organization (WHO) in 2001, prevalence based YLD was given as:

$$YLD_x = P_x * DW_x$$

where P_x is the total cases in age group x prevalent at any point of time during the reference period, and DW_x is the disability weight. The GBDS provides the disease-specific disability weights in the range 0-1 (Appendix 3.1), and the prevalence rates have been computed from the NSSO data, round 60 (2004). The precise method of estimating YLD has been discussed in the next section of this chapter.

We know that Disability Adjusted Life Years (DALY) has two components: Years Lost due to Disability (YLD) and Years of Life Lost due to Premature Mortality (YLL). In this chapter, our second objective is to measure the sex differences in YLL in India based on age-specific mortality rates provided by the Sample Registration System (SRS), 2004.

3.2. Methodology

3.2.1. Disability weights of diseases

For the computation of YLD, we have used the disability weights of GBDS-1990 or, in some cases, the GBDS-2010 (where the disability weight for an ailment is not available from the GBDS 1990). According to the Global Burden of Disease Study, disability weights are different for treated and untreated cases and vary with age. For our study, we have used the information on disability weights of different age groups and the proportions of cases receiving treatment for various diseases in India from the Annex Table 3 and 4, respectively in the book “Global Burden of Disease and Injury Series, Volume 1” (Murray and Lopez eds., 1996).

For a few diseases, the disability weights do not vary with age or the condition of being treated or not, such as upper respiratory infections, terminal cancers, dental caries etc. If the data on proportion treated is available for any disease, we have calculated the average disability weight as:

Average Disability Weight (ADW) = $P_1*DW_T + P_2*DW_{UT}$

where P_1 = proportion treated, P_2 = proportion untreated, DW_T = disability weight for treated and DW_{UT} = disability weight for untreated persons

Also, we have to match the ailments given by the NSS to those of GBDS to get the appropriate disability weights. Below we have discussed the disability weights used in the present study for various ailments.

To estimate the YLD for diarrhoea/dysentery, we used the disability weights of diarrhoeal diseases (episodes) provided by GBDS 1990. In this case, the disability weight varies with age. Table 3.1 provides the estimation of YLD from diarrhoea/dysentery in India in 2004.

In the case of gastritis/gastric/peptic ulcer, the disability weight of peptic ulcer given by GBDS 1990 has been considered as no separate disability weight for gastritis has been found. According to GBDS 1990, 65 per cent of people suffering from peptic ulcers were treated in India. The disability weight is 0.003 for those treated with antibiotics and 0.115 for those who were not treated. Therefore, the average disability weight for gastritis/gastric/peptic ulcer is calculated as (.65*0.003 + .35* 0.115) = 0.042 (applying the formula, ADW = $P_1*DW_T + P_2*DW_{UT}$).

The GBDS 1990 provides disability weights of various kinds of worm infestation (e.g., hookworm, ascariasis etc.) separately. On the other hand, GBDS 2010 provides average disability weight of only intestinal nematode infections (symptomatic), the most common worm infestation in India (Kumar, Jain and Jain, 2014). Therefore, in our study, the disability weight of intestinal nematode infections has been used for worm infestation.

GBDS does not provide the disability weight of amoebiasis. However, symptoms of amoebiasis can range “from mild abdominal discomfort and diarrhoea to acute fulminating dysentery" (Park, 2009, p. 213). As 90 per cent of infected people from this disease are asymptomatic (Haque et al., 2003), it is assumed that the majority of the reported amoebiosis cases are symptomatic. In this context, we have used the disability weight of diarrhoeal diseases (episodes) provided by GBDS 1990 for amoebiosis. For hepatitis/jaundice, we have used the disability weight of hepatitis B (episodes) as provided by GBD 1990. The disability weight of Hepatitis B is the same as of Hepatitis C and varies with age.

Heart disease can be of several types. Coronary heart disease (CHD) or ischemic heart disease is India's most common heart disease (Prabhakaran, Jeemon and Roy, 2016). "CHD includes conditions such as cardiomyopathies, acute MI, angina pectoris, congestive heart failure and inflammatory heart disease" (Indrayan, 2005, p. 198). The GBDS 1990 provides information on disability weights (treated and untreated) and the proportion of the population treated for acute myocardial infarction (MI), angina pectoris, and congestive heart failure. However, their proportion among the Indian population is not available. Therefore, we have taken the average disability weights of these three types of CHD for estimating YLD from heart disease. The disability weight of heart disease used in this study has been calculated in the following manner:

	Disability weight		Proportion treated
Types of coronary heart disease	Treated	Untreated	
Acute myocardial infarction	0.395	0.491	0.20
Angina pectoris	0.095	0.227	0.20
Congestive heart failure	0.171	0.323	0.20
Average	0.220	0.347	0.20

The average disability weight of heart disease = (.20*0.220 + .80*0.347) = 0.322 (Applying the formula $ADW = P_1*DW_T + P_2*DW_{UT}$)

In the case of hypertension, the disability weight is not provided by the GBDS. It may be assumed that, until hypertension is causing heart disease or any other disease, it is not treated as a disability. When it is causing a disease, the person is considered to have that disease and not hypertension.

Calculating disability weight for respiratory disease, including ear/nose/throat ailment, is problematic because GBDS 1990 provides disability weight for

"Lower respiratory infections

Episodes

Chronic sequelae

Upper respiratory infections

Episodes

Pharyngitis

Otitis media

Episodes

Deafness" (Murray and Lopez, 1996, pp. 413-414)

The most common lower respiratory tract infection (LRI) is pneumonia (Finegold and Johnson, 1985). As episodes of pneumonia are more common (Ruuskanen et al., 2011), we have considered the weight of LRI episodes for the disability weight of lower respiratory infections. According to GBDS 1990, LRI episodes vary with age. We have used the disability weight for children (0.280) because they are more prone to acute lower respiratory infections in developing countries (Niederman and Krilov, 2013). The most common upper respiratory tract infection (URI) is the common cold. Sinusitis, tonsillitis, otitis media and pharyngitis are upper respiratory tract infections (Jain, Lodha and Kabra, 2001). The disability weight of upper respiratory infections is derived by averaging the disability weights of URI: episodes (0.000), URI: Pharyngitis (0.070) and Otitis media: Episodes (0.023) provided by GBDS 1990. We have used the disability weight of children for Otitis media: Episodes because commonly, children aged 6 to 36 months suffer from it (Swanson and Hoecker, 1996). As untreated acute otitis media can seldom lead to permanent hearing loss, we have not considered Otitis media: Deafness to calculate the disability weight of URI (nationwidechildrens.org, 2021). According to one study by Acharya et al. (2003) in South India, 86 per cent of total acute respiratory infections were URI. Therefore, the average disability weight of respiratory disease is derived as $P_1*DW_1 + P_2*DW_2$ where P_1 = proportion URI, P_2 = proportion LRI, DW_1 = disability weight for URI and DW_2 = disability weight for LRI.

For tuberculosis, we have used the disability weight from GBDS 1990. Age-wise variation of DW has been taken into account in the estimation of YLD from tuberculosis. Based on the information of disability weights of bronchial asthma for treated and untreated patients and proportion treated from GBDS 1990, we have computed the average disability weight of the disease.

The disability weight (DW) of disorders of joints and bones has been estimated using the disability weights of osteoarthritis (OA) and rheumatoid arthritis (RA). In India, the prevalence rate of osteoarthritis ranges between 22 per cent and 39 per cent, while 0.5 to 1 per cent population suffer from the autoimmune disease – rheumatoid arthritis (ANI, 2017). Taking the average, we have considered 30.5 per cent and 0.75 per cent population in India are affected by osteoarthritis and rheumatoid arthritis, respectively. Therefore, in India, of total arthritis patients, 98 per cent suffers from osteoarthritis, and only 2 per cent experiences rheumatoid arthritis. As disability weights for treated and untreated patients of osteoarthritis and rheumatoid arthritis are given separately in GBDs 1990 along with the information of proportion treated, at first, we have estimated average disability weights for osteoarthritis and rheumatoid arthritis separately using the formula $ADW = P_1{*}DW_T + P_2{*}DW_{UT}$ where, ADW= average disability weight, P_1 = proportion treated, P_2 = proportion untreated, DW_T = disability weight for treated and DW_{UT} = disability weight for untreated persons. Finally, we have computed the weighted disability weights using the formula (proportion OA* DW_{OA} + proportion RA *DW_{RA}).

We used the average disability weight of chronic kidney disease (Stage IV) provided by GBDS 2010 to estimate YLD for kidney/urinary system diseases. As a very meagre percentage (0.15-0.20/year over the next 10-25 years) reach end-stage renal disease (Varma, 2015), we have not used the disability weight of end-stage renal disease.

In NSS Round 60, gynaecological disorders were regarded as an ailment. The major gynaecological problems include menstrual problems, excessive discharge, lower abdominal pain, vaginitis, cervicitis etc. (Koenig et al., 1998). However, disability weights for overall gynaecological problems or any type of above gynaecological disorders are not found in GBDS 1990. GBDS 2010 provides disability weights for primary and secondary infertility, but it is unwise to use the disability weight of infertility for gynaecological problems. For prostatic disorders, we have used the disability weight of benign prostatic hypertrophy-symptomatic cases from GBDS 1990.

Under neurological disorders, there are various neurological diseases. In one article, Gourie-Devi (2008) has compared the prevalence of common neurological disorders found in multiple studies conducted in India. Below we have shown these diseases and provided their prevalence rate based on a recent community-based study from South India (Gourie-Devi et al., 2004). We used the disability weights of these diseases to calculate the average disability weight for neurological disorders in the following manner:

Types of neurological disorders found in India	Prevalence (P) per 1000, 2004	Disability weight (DW)	P*DW
Epilepsy	8.83	0.133	1.174
Headache	11.19	0.029	0.325
Cerebrovascular: Stroke	1.50	0.271	0.408
Mental retardation & cerebral palsy	1.42	0.425	0.604
Parkinson's disease	0.33	0.391	0.129
Peripheral neuropathy	1.28	0.099	0.127
Post poliomyelitis sequel	1.10	0.292	0.321
Total	25.65		3.087

The average disability weight for neurological disorders = 3.087 /25.65 = 0.120

In the above table, we used the average disability weights for epilepsy, cerebrovascular: stroke, and Parkinson's disease. Information on the proportion treated in India for those diseases and the disability weights of treated and untreated are available in GBDS 1990. Also, for epilepsy, the disability weights of 0-4 age group and for cerebrovascular: stroke and Parkinson's disease, the disability weights of 60+ populations have been considered as epilepsy is more common among the children and Parkinson's disease and stroke mainly affect the elderly. Further, for Peripheral neuropathy, we have taken the average disability weights of diabetic neuropathy from GBDS 2010. For mental retardation & cerebral palsy, we have used the average disability weight of severe motor plus cognitive impairments from GBDS 2010. For post poliomyelitis sequel, we have used the average disability weight of musculoskeletal problems (generalised, moderate) from GBDS 2010. The disability weight of migraine provided by GBDS 1990 is used for headaches.

The computation of the average disability weight for psychiatric disorders is similar to the calculation of neurological disorders. An epidemiological study of mental disorders in Maharashtra by Deswal and Pawar (2012) recognised a range of psychiatric problems among the population in India, namely, depression, substance use, panic disorder, social phobia and general anxiety. Disability weights of these diseases or comparable diseases have been used to calculate the average disability weight of psychiatric disorders. For example, in the case of general anxiety, the weight of anxiety disorder has been used. We have computed the disability weight of general anxiety by taking the average of mild, moderate and severe anxiety disorder provided by GBDS 2010. The disability weight of general anxiety is also used for social phobia. The disability weight of substance use is computed by averaging the disability weights of alcohol dependence syndrome and harmful drug use (GBDS 1990). We have used the disability weights of unipolar depressive disorders for depression, taking into account the disability weights of treated and untreated patients (GBDS 1990). The computation of average disability weight of psychiatric disorders is shown below:

Types of psychiatric disorders found in India	Prevalence (P) per 1000, 2004	Disability weight (DW)	P*DW
Depression	3.14	0.353	1.108
Substance use	1.39	0.216	0.300
Panic disorder	0.86	0.169	0.145
Social phobia	0.03	0.234	0.007
General anxiety	0.17	0.234	0.040
Total	5.59		1.601

The average disability weight for psychiatric disorders = 1.601 /5.59 = 0.286

In glaucoma, GBDS 1990 provides separate disability weights for low vision and blindness from glaucoma (Mathers et al., 2006). Five population-based studies conducted in India between 1993 and 2003 show that around six per cent of people suffering from glaucoma were diagnosed with blindness (George and Vijaya, 2007). We assume that the rest (i.e. 94 per cent) were subjected to the low vision from glaucoma. We used this estimate to calculate the average disability weight of glaucoma. It is derived as P_1*DW_1 + P_2*DW_2 where P_1 = proportion low vision, P_2 = proportion blindness, DW_1 = disability weight for low vision and DW_2 = disability weight for blindness.

Based on a nationwide survey conducted in India in 1999-2001, the prevalence of low vision and cataract blindness was found at 23.85 per cent and 5.3 per cent, respectively (Venkata et al., 2005). Another study found that 74.2 per cent of low vision was caused by cataracts (Dineen et al., 2003). Therefore, the prevalence of low vision from cataracts is (23.85*74.2%) = 17.7 per cent. Using the data and disability weights of treated and untreated patients from GBDS 1990, we separately calculated the average disability weights of low vision and blindness from cataracts. Finally, using the proportions and disability weights of cataract related low vision and blindness, the average disability weight of cataracts has been computed.

The age-standardised prevalence rate of diabetes in India was 12.1 per cent in 2000 (Ramachandran et al., 2001). One study from India found that among newly diagnosed patients with Type-2 diabetes, 13.15 per cent had neuropathy, 6.1 per cent had retinopathy, 1.06 per cent had nephropathy, and 6.0 per cent reported ischemic heart disease (Sosale et al., 2014). Diabetic foot ulcers were found among 4.54 per cent of newly diagnosed diabetes mellitus patients (Sinharay et al., 2012). Based on the above information, the prevalence of diabetic neuropathy in India is estimated as (12.1 *13.15%) = 1.59 per cent. Similarly, the prevalence of other diabetes-related diseases has been calculated. The GBDS 1990 provides disability weights for diabetes cases, diabetic foot, amputation, neuropathy and retinopathy. For nephropathy, we have used the disability weights of end-stage renal disease (GBDS 1990). We used the disability weight of ischemic heart disease (IHD) calculated earlier in this chapter for diabetes-related IHD. Patients with diabetes but no complications are considered diabetic cases. Using the proportion treated and disability weights of treated and untreated from GBDS 1990, we have calculated the average disability weights for each diabetes-related complication, applying the formula $ADW = P_1*DW_T + P_2*DW_{UT}$. The final disability weight for diabetes has been calculated as:

Diabetes related complications	Prevalence (P) per 1000, 2006-11	Disability weight (DW)	P*DW
Diabetes cases	8.37	0.013	0.109
Neuropathy	1.59	0.075	0.120
Retinopathy-blindness	0.74	0.566	0.233
Nephropathy	0.13	0.102	0.013
Ischemic heart disease	0.73	0.322	0.418
Diabetic foot	0.55	0.135	0.074
Total	12.10		0.968

The average disability weight for diabetes = 0.968 /12.10 = 0.080

For under-nutrition, we used the average disability weight of severe wasting provided by GBDS 2010.

In India, the estimation of mild, moderate and severe anaemia prevalence among children (0-4 years) and those aged 15-49 years (both males and females) are available from the report of NFHS-3 (IIPS and Macro International, 2007). On the other hand, the disability weights for mild, moderate and severe anaemia has been provided by GBDS 2010. Based on that information, the average disability weights of boys in the age group 0-4 years have been calculated using the formula ADW= $P_1*DW_1 + P_2*DW_2 + P_3*DW_3$ where, ADW= average disability weight, P_1 = proportion with mild anaemia, P_2 = proportion with moderate anaemia, P_3 = proportion with severe anaemia, DW_1 = disability weight of mild anaemia, DW_2 = disability weight of moderate anaemia, and DW_3 = disability weight of severe anaemia. Similarly, the average disability weights for girls in the age group 0-4 years and males and females aged 15-49 years have been computed. We have applied the disability weight of age group 0-4 years to the following two age groups and the disability weight of 15-49 years to the rest of the age groups for the calculation of YLD.

We did not compute the average disability weight for sexually transmitted diseases (STDs) because GBDS 1990 provides disability weights of various categories of STD-related complications (weight ranges between .000 and .549). Such specifications are not available for India from the existing literature.

For malaria, the disability weight of malaria episodes has been considered. We used the disability weights of various age groups as given in GBDS 1990 to estimate the YLD from malaria. In case of eruptive, the average disability weight of herpes zoster (GBDS 2010) has been used for our analysis. GBDS does not provide disability weight of mumps, and comparable disease with mumps has not been found from the literature review. Therefore, we are unable to compute YLD from mumps.

The disability weights of diphtheria episodes and myocarditis provided by GBDS 1990 have been used in diphtheria. The proportions of these two conditions are taken as 0.3 and 0.7 based on a study from a tertiary referral infectious disease hospital between 1994 and 2002 in India (Kole et al., 2012). Another study also found 66.6 per cent of patients with diphtheria suffered from myocarditis (Jayashree et al., 2006). However, most of the patients only show some changes in ECG without any symptoms of failure or shock (Singh et al., 2010). We have computed the average disability weights of diptheria using the formula $P_1*DW_1 + P_2*DW_2$ where P_1 = proportion diphtheria episodes, P_2 = proportion diphtheritic myocarditis, DW_1 = disability weight for diphtheria episodes and DW_2 = disability weight for diphtheritic myocarditis.

According to GBDS 1990, the disability weight for whooping cough or pertussis varies with pertussis episodes and mental retardation. Also, disability weights are different for pertussis treated and untreated. However, we did not find any study showing such proportions in India. Therefore, we cannot compute disability weights for whooping cough.

The average disability weights for fever of unknown origin and other diagnosed and other undiagnosed ailments also cannot be estimated as no specific diseases are mentioned under these broad categories.

In the present study, the age-specific disability weights of tetanus are obtained from GBDS 1990. For filariasis/elephantiasis, we have used the average disability weight of symptomatic lymphatic filariasis from GBDS 2010.

It is also not possible to compute the average disability weights for locomotor disability and accidents/injuries/burns/fractures/poisoning because GBDS provides the disability weights for the sub-categories of these ailments/conditions, the proportion of which are not available in the existing literature from India.

In India, about 6.3 per cent population suffers from hearing loss (Garg et al., 2009). The 58^{th} round of the National Sample Survey (2002) revealed that 32 per cent of people in India reported profound hearing loss, and 39 per cent reported considerable hearing disability (Singh, 2015). Based on the above information, we can say that in India, 2.02 (6.3*32) per cent, 2.46 (6.3*39) per cent, and 1.9 per cent of people suffer from severe, moderate, and mild hearing disabilities, respectively. For calculating average disability weight, we used the information on treated and untreated weight for mild, moderate and severe hearing loss from provisional disability weight based on GBD 1990 and Netherlands disability weights study for comparable health states (Mathers et al., 2006). The average disability weight for each category was computed using the information on disability weights and proportions treated and untreated using the formula ($P_1*DW_T + P_2*DW_{UT}$). Then the weighted average disability weight for hearing disability was estimated as ($P_1*DW_1 + P_2*DW_2 + P_3*DW_3$) where P_1, P_2 and P_3 are the proportion of the population with mild, moderate and severe hearing disability, respectively, and DW_1, DW_2 and DW_3 are the average disability weights of the respective category.

In India, the prevalence of low vision and blindness were found 23.85 per cent and 8.5 per cent, respectively, in 1999-2001 (Venkata et al., 2005). The prevalence of cataract blindness in India was 5.3 per cent in 1999-2001 (Murthy et al., 2005). Therefore, the prevalence of blindness from other than cataracts was 3.2 (8.5- 5.3) per cent. A nationwide study from Bangladesh reveals that the leading cause of low vision was cataracts (74.2%). Using this proportion for India, we find that the prevalence of low vision other than cataracts was 6.15 (23.85- 23.85*74.2) per cent. This information on prevalence and corresponding disability weights (from GBDS 1990) are applied to estimate the average disability weight for visual disability, excluding cataracts.

For speech disability, the average disability weight of speech problems from GBDS 2010 has been used in our study. To compute the YLD from diseases of mouth/teeth/gum, we have considered the disability weight of the episodes of dental caries because 60-65 per cent of people in India are affected by dental caries (Lin and Mauk, 2012).

In GBDS, the disability weights (both treated and untreated) of various cancers are given. Below we have estimated the average disability weight of cancer and other tumours for females:

Types of cancer	Incidence per 100,000[a]	DW for treated (T)[b]	DW for untreated(UT)[b]	I*DW (T)	I*DW (UT)
Mouth & oropharynx	5.52	0.090	0.145	0.497	0.800
Stomach	2.65	0.217	0.217	0.575	0.575
Colon & rectum	2.88	0.217	0.217	0.625	0.625
Liver	0.84	0.239	0.239	0.201	0.201
Pancreas	0.79	0.237	0.301	0.187	0.238
Trachea, bronchus & lungs	1.78	0.146	0.146	0.260	0.260
Breast	20.01	0.086	0.069	1.721	1.381
Bladder	0.74	0.085	0.085	0.063	0.063
Leukemia	2.84	0.097	0.112	0.275	0.318
Lymphomas & multiple myeloma	3.13	0.057	0.089	0.178	0.279
Oesophagus	3.15	0.217	0.217	0.684	0.684
Melanoma & skin	0.94	0.045	0.045	0.042	0.042
Cervix	14.42	0.075	0.066	1.082	0.952
Ovary	5.6	0.084	0.081	0.470	0.454
Corpus uteri	2.43	0.079	0.066	0.192	0.160
Total	67.72			7.052	7.031
Average disability weight				0.104	0.104

Source: [a] Park, 2009, p-333, [b] GBDS 1990

More than 10 lakh new cancer cases in India are diagnosed every year, and around 50% of these are in advanced stages (Mehta, 2014). According to GBDS 1990, the weight of cancer at the terminal stage was 0.809 and the proportion treated for cancer is 0.20 in India. The above calculation shows that the average disability weights for treated and untreated cancer patients are the same; therefore, the weighted average disability weight for cancer among females = (0.5*0.104 + 0.5*0.809) = 0.457. Here it should be mentioned that for leukaemia, corpus uteri, bladder and ovarian cancer, the disability weight varies with age. Therefore, we have considered the disability weights of those age groups more likely to be affected by these diseases. The average disability weight of cancer and other tumours for males has been computed as follows:

Types of cancer	Incidence per 100,000[a]	DW for treated (T)[b]	DW for untreated(UT)[b]	I*DW (T)	I*DW (UT)
Mouth & oropharynx	12.48	0.090	0.145	1.123	1.810
Trachea, bronchus & lungs	6.62	0.146	0.146	0.967	0.967
Lymphomas & multiple myeloma	5.04	0.057	0.089	0.287	0.449
Oesophagus	4.47	0.217	0.217	0.970	0.970
Leukaemia	4.07	0.097	0.112	0.395	0.456
Colon & rectum	3.86	0.217	0.217	0.838	0.838
Liver	3.71	0.239	0.239	0.887	0.887
Prostate	3.57	0.134	0.113	0.478	0.403
Bladder	2.35	0.085	0.085	0.200	0.200
Pancreas	1.27	0.237	0.301	0.301	0.382
Melanoma & skin	1.05	0.045	0.045	0.047	0.047
Stomach	3.78	0.217	0.217	0.820	0.820
Total	52.27			7.313	8.228
Average disability weight				0.140	0.157

Source: [a] Park, 2009, p-333, [b] GBDS 1990

According to GBDS 1990, in India proportion treated in cancer is 0.20. Therefore, the average disability weight for cancer is (.20*0.140+.80*0.157) = 0.154 for those not in terminal stage. Considering 50 per cent cases are terminal cases, the weighted average disability weight for cancer for males is = (0.5*0.154 + 0.5*0.809) = 0.481.

3.2.2. Computation of YLD

We have estimated disease-specific YLD using the following steps:

Step 1: Based on NSS data, age-sex specific prevalence rates are calculated for each ailment.

Step 2: Age-sex specific population of India in 2004 have been derived by interpolating the population of 2001 and 2006 provided by the Office of the Registrar General & Census Commissioner, India (2006).

Step 3: Now, we have multiplied NSS prevalence rates to the census-based population of 2004 of respective age groups, which provides the age-specific cases of point prevalence (P_x).

Step 4: P_x is multiplied by disability weights (DW_x) of the corresponding ailment. P_x*DW_x of all the age groups are then added to obtain the YLD for a particular disease/condition.

Table 3.1 shows the computation of YLD for males in India in 2004 from diarrhoea/dysentery. Here, disability weight (taken from GBDS 1990) does not change for treated and untreated persons but varies with age.

Table 3.1: Estimation of YLDs from Diarrhoea/Dysentery for males in India, 2004

Age	Point Prevalence	Male Population	Prevalence rate per thousand	Male population in ’000	Prevalence in ’000 (P_x)	Disability weights (DW_x)	YLD in ’000 (P_x*DW_x)
	NSS	NSS	NSS	Census-based		GBDS 1990	
0	124	21452	6.20	61595	382	0.119	45.4
5	28	22540	1.11	62687	70	0.094	6.5
10	10	21974	0.19	63564	12	0.094	1.2
15	13	19210	0.64	59705	38	0.086	3.3
20	4	16806	0.04	51652	2	0.086	0.2
25	10	15937	0.79	44707	35	0.086	3.0
30	6	14204	0.19	40017	8	0.086	0.7
35	11	13065	1.27	36484	46	0.086	4.0
40	2	10444	0.17	32589	6	0.086	0.5
45	10	8848	0.92	27574	25	0.086	2.2
50	6	6713	0.52	22136	11	0.086	1.0
55	7	6769	0.84	17045	14	0.086	1.2
60	14	6399	1.68	13271	22	0.088	2.0
65	9	4981	1.18	10505	12	0.088	1.1
70	10	3350	1.25	8019	10	0.088	0.9
75	5	1472	1.83	4609	8	0.088	0.7
80+	7	1524	3.54	2020	7	0.088	0.6
	276	195688	1.30	558180	723		74.5

Note: Prevalence rates have been computed using sample weights

3.2.3. Computation of YLL

In the GBDS, “cause patterns of mortality were based on the Medical Certification of Cause of Death (MCCD) database for urban areas of India and the Annual Survey of Causes of Death for rural areas of India...which were summed to obtain national cause-specific mortality estimates” (Mathers et al., 2006, p. 60). In India, the number of medically certified deaths to the total registered deaths is meagre – only 20 per cent in 2012 (ORG, India, 2015). The Annual Survey of Causes of Death, based on verbal autopsy, was merged with the Sample Registration System in 1999 to cover both the urban and the rural areas. However, only a few diseases identified in the ‘Report on Causes of Death: 2001-2003’ are comparable to those presented in NSS 2004 (ORG, India, 2009). Because of data constraints, we did not estimate YLL by cause/disease. Hence, disease-specific DALY also could not be computed.

In this chapter, we have calculated India's total YLL based on the age-specific mortality rates (from all causes) of the Sample Registration System (SRS) 2004. The estimation of YLL depends on the information of Age-Specific Death Rate (ASDR) and Standard Life Expectancy (SLE). The GBDS provided SLE for males and females separately (Murray and Lopez, eds, 1996, p-17); therefore, we have calculated YLL by gender. The methodology used to estimate YLL is described below:

Step 1: Both India's male and female population in 2004 have been derived by interpolating the 2001 and 2006 population data provided by the Office of the Registrar General & Census Commissioner, India (2006). The population is presented in 5-year age groups.

Step 2: The male and female Age-Specific Death Rates of 2004 provided by SRS (Registrar General, India, 2006) are applied to the population of India of 2004 to get the number of deaths in each age group. As the number of population of 2001 and 2006 is specified up to age 80+ and the ASDR is provided up to age 85+, we have pooled ASDR using 2001 census data (Table C-13, Single year age returns by Residence and Sex) in accordance to census age group 80+ by the following formula:

$$ASDR_{80+} = [(P_{80-84} * ASDR_{80-84}) + (P_{85+} * ASDR_{85+})] / (P_{80-84} + P_{85+})$$

Where P_{80-84} and P_{85+} refer to the census population of the age groups 80-84 years and 85+ respectively; $ASDR_{80-84}$ and $ASDR_{85+}$ refer to age-specific death rates of the age groups 80-84 years and 85+ respectively.

Here we assumed that there wouldn't be much difference in death rates among population 80+ between 2001 and 2004. Before computing the ASDR for population 80+, the census population of 2001 is adjusted for 'age not stated'. The population of 'age not stated' is proportionally distributed among single year population of 2001. The data is then smoothened by the 3-year moving average method. For the last age group (100+), we have estimated the average of the previous four single-year age distributions. Appendix 3.2 shows the distribution of the number of deaths of females of India (2004) by age. The same exercise has also been carried out for males.

Step 3: The number of deaths in each age group is multiplied by the corresponding Standard Life Expectancy (SLE) to obtain YLL for males and females (Table 3.3 and 3.4). This seemingly easy exercise has its own complexity. We have the ASDR for the age group 80+, but SLE is given at age 0, 5,10,…,80,85,..,100 (Murray and Lopez, eds, 1996). Therefore, we need to estimate SLE for the age group 80+. For this purpose, we first calculated the average age at death for the age group 80+, using the appropriate UN extended model life tables up to age 100+ (Family-West, Type- CD West). As the life expectancy in India in 2001-2005 was

63.8 for males and 66.1 for females (Office of the Registrar General & Census Commissioner, India, 2006), we have chosen the model life tables of e^0= 62.5 years for males and e^0= 65.0 years for females. The number of deaths in each age group (a) is derived by multiplying the age-specific census population with model life table ASDR. The average age at death (b) in each age group (starting from 80-84 years) has been determined by adding the lower limit of that age group and the average years lived in the age group by those who died in that age group (available from model life table $_na_x$ value). Now the average age at death for the population 80+ is estimated by the following formula:

$$\sum (a^* b) / \sum a$$

where a = Number of deaths in each age group starting from 80-84 years up to 100+

b = Average age at death in that age group

Appendix 3.3 shows the estimation of average age at death for 80+ female populations in India in 2004. It is estimated at 88.51 years. The same exercise was also carried out for males.

Step 4: SLE at ages 80 and 85 years are available in the book "Global Burden of Disease and Injury Series, Volume 1" (Murray & Lopez, eds, 1996). Now we can estimate SLE at age 80+ by simply applying interpolation. For example, SLE for females reduces by 2.68 years between ages 80 and 85 years. So, between ages 80 and 88.51 years, it will decrease by 4.56 years. SLE at 80 is given as 8.90 years. Therefore, SLE at 80+ is (8.90 – 4.56) years, i.e., 4.34 years.

3.3. Results

3.3.1. Estimated YLD by sex

Table 3.2 presents YLDs from various ailments in India by sex for 2004.

Table 3.2: Estimated YLDs from various ailments in India by sex, 2004

Ailment types/conditions	YLD ('000)		
	Male	Female	Total
"Diarrhoea/ Dysentery	74.5	66.5	141.0
Amoebiosis	11.1	10.4	21.5
Worm infestation	3.2	2.1	5.3
Gastritis/ Gastric or peptic ulcer	50.4	62.8	113.2
Hepatitis/ Jaundice	46.9	19.5	66.4
Disorders of joints and bones	337.5	543.8	881.3
Bronchial asthma	162.9	107.6	270.5
Respiratory disease including	154.0	138.4	292.4

ear/nose/throat ailment			
Tuberculosis	194.6	127.1	321.7
Heart disease	483.7	385.7	869.4
Diseases of kidney/ urinary system	54.6	36.9	91.5
Psychiatric disorders	95.9	98.9	194.8
Neurological disorders	107.0	125.1	232.1
Diabetes mellitus	155.7	140.8	296.5
Malaria	52.9	60.9	113.8
Prostatic disorders	3.2	NA[1]	3.2
Cataract	228.6	320.0	548.6
Glaucoma	30.6	40.8	71.4
Goitre	5.5	15.1	20.6
Anaemia	4.1	9.5	13.6
Under-nutrition	7.6	5.3	12.9
Filariasis/ Elephantiasis	3.3	9.2	12.5
Diseases of skin	60.1	51.9	112.0
Diphtheria	9.6	4.9	14.5
Tetanus	9.4	5.7	15.1
Eruptive	6.5	7.5	14.0
Cancer and other tumours	122.0	124.5	246.5
Diseases of mouth/teeth/gum	18.0	29.7	47.7
Visual disability (excluding cataracts)	189.9	235.5	425.4
Hearing disability	65.0	64.5	129.5
Speech disability”	9.1	5.5	14.6

Source: National Sample Survey Organisation, 2006 (for types of ailments)
Note: NA[1] = Not Applicable

NSS 2004 provided information on 37 ailments excluding fever of unknown origin, other diagnosed ailments, and other undiagnosed ailments. We have estimated YLD for 31 types as the average disability weights are unavailable or could not be computed for six diseases/conditions.

We observed that in 2004 in India, two diseases that contributed to very high non-fatal health outcomes were disorders of joints and bones and heart disease. The total YLD attributable to joints and bones disorders and heart disease was estimated at 881.3 thousand and 869.4 thousand, respectively. It is interesting to note that the prevalence rate of diabetes mellitus was substantially higher in 2004 compared to cataracts. However, the disability weights of cataract related blindness and low vision provided by the GBDS 1990 were 0.600 and 0.271, respectively, which were much higher than our estimated disability weights of diabetes mellitus (0.080). From the disability weight calculation, we found that diabetic foot and diabetes-related retinopathy, nephropathy and ischemic heart disease have higher disability weights than simple diabetic cases, but a small proportion of the population suffers from these complications. As the disability weight of diabetic cases was only 0.013, the total number of years lost due to disability was found higher for cataracts than diabetes mellitus.

We found that YLD was more than 1.5 times higher for women than men in case of joint and bone disorder, anaemia, filariasis/elephantiasis, goitre and diseases of mouth/teeth/gum in 2004. In cases of tuberculosis, hepatitis/jaundice, worm infestation, asthma, diseases of kidney/urinary system, diphtheria, tetanus and speech disability, YLD was at least 1.5 times higher for men than women.

3.3.2. Estimated YLL by sex

Tables 3.3 and 3.4 presents the number of years lost due to premature mortality for males and females, respectively, in India in 2004.

Table 3.3: Estimation of YLL for males in India, 2004

Age (x)	N	Population in ’000[a]	ASDR per 1000[b]	Number of deaths per 1000 (a)	SLE[c] (b)	YLL in '000 a*b
0	5	61595	16.6	1022	80.00	81798
5	5	62687	1.5	94	75.38	7088
10	5	63564	1.0	64	70.40	4475
15	5	59705	1.5	90	65.41	5858
20	5	51652	1.9	98	60.44	5932
25	5	44707	2.5	112	55.47	6200
30	5	40017	3.2	128	50.51	6468
35	5	36484	3.8	139	45.57	6318
40	5	32589	5.3	173	40.64	7019
45	5	27574	6.7	185	35.77	6608
50	5	22136	10.0	221	30.99	6860
55	5	17045	13.7	234	26.32	6146
60	5	13271	24.6	326	21.81	7120
65	5	10505	35.0	368	17.50	6434
70	5	8019	55.5	445	13.58	6044
75	5	4609	80.0	369	10.17	3750
80+		2020	150.5	304	3.83	1164
Total		558180		4371		175283

Note: [a] Estimated population of 2004
[b] Source: Registrar General, India (2006): Sample Registration System: Statistical Report 2004
[c] Source: Murray & Lopez, 1996; SLE for age 80+ has been calculated by the researcher

Table 3.4: Estimation of YLL for females in India, 2004

Age (x)	N	Population in '000[a]	ASDR per 1000[b]	Number of deaths per 1000 (a)	SLE[c] (b)	YLL in '000 a*b
0	5	56106	17.5	982	82.50	81003
5	5	58212	1.5	87	77.95	6806
10	5	57867	0.9	52	77.99	4062
15	5	53344	1.7	91	68.02	6188
20	5	46590	2.1	98	63.08	6172
25	5	42448	2.0	85	58.17	4938
30	5	39433	2.4	95	53.27	5041
35	5	35525	2.3	82	48.38	3953
40	5	30445	3.0	91	43.53	3976
45	5	24834	4.8	119	38.72	4616
50	5	19829	5.7	113	33.99	3842
55	5	15947	10.9	174	29.37	5105
60	5	13470	17.2	232	24.83	5753
65	5	11204	25.5	286	20.44	5840
70	5	8495	44.3	376	16.20	6097
75	5	4721	62.4	295	12.28	3617
80+		2107	135.1	285	4.34	1235
Total		520576		3542		158225

Note: [a] Estimated population of 2004
[b] Source: Registrar General, India (2006): Sample Registration System: Statistical Report 2004
[c] Source: Murray & Lopez, 1996; SLE for age 80+ has been calculated by the researcher

In 2004 in India, the years of life lost due to premature mortality were estimated as 333.5 million, of which 175.3 million YLL was counted for males and 158.2 million for females. In other words, the estimated YLL per 100,000 males and females were 31403 and 30349, respectively. Higher YLL was observed among the males than the females in most of the age groups.

In 2004, the age-specific death rates (ASDR) were higher among the males than the females in most age groups (Office of the Registrar General, India, 2006). The difference was conspicuously higher among the elderly (for example, in the age group 74-79 years, ASDR was 62.4 per 1000 for females and 80 per 1000 for males). Higher ASDR combined with a higher male population in the majority of the age groups were responsible for the observed gender difference in YLL in 2004 in India. From our calculation, the crude death rates were found as 7.8 and 6.8 for males and females, respectively, which was close to SRS estimation (8.0 for males and 7.0 for females) for that year.

3.4. Conclusion

In this chapter, we have estimated YLD by cause/ailments following the prevalence approach. The disease-specific YLD published by India State-level Disease Burden Initiative Collaborators in 2017 was also based on the prevalence approach. We observed that in India, two non-communicable diseases – heart disease and diseases of joints and bones contributed to the maximum number of YLD in 2004. Among the infectious diseases, tuberculosis appeared to be the most devastating disease contributing to 321700 YLD in 2004. Therefore, greater initiatives are required by the government to prevent and control these diseases to improve the quality of life of India’s population.

We found significant gender differences in YLD for some diseases. Therefore, the policies and programmes directed to reduce the disease burden must consider the gender aspect of illness. YLL also varies with gender. In 2004, the estimated YLL was 31403 per 100,000 males and 30349 per 100,000 females in India. The higher age-specific death rates among the males are mainly responsible for the observed gender difference in YLL. Higher ASDR among males is a typical pattern throughout the world. But unlike the developed countries, the mortality rates in the age group 0 to 4 years is much higher in India. To reduce the burden of YLL in India, reducing mortality rates, particularly among children, is a prerequisite.

Chapter 4

Ailment-Free Life Expectancies and Burden of Communicable and Non-communicable Diseases in India, 2004 and 2017-18

4.1. Introduction

Disability Adjusted Life Years (DALY) is the most common measure of the health gap, but there is a dearth of data for estimating DALY for India. Also, the procedure to calculate DALY followed by the Global Burden of Disease Study (GBDS) is not only complex; it needs an amalgamation of researchers and professionals and substantial financial assistance. In contrast, Disability-Free Life Expectancy (DFLE) is one of the simplest and widely used measures of health expectancy. DFLE, proposed by Sullivan in 1971, is based on an abridged life table and the prevalence of disability by age groups (Sullivan, 1971). Therefore, in terms of SMPH, it is more convenient to use DFLE than DALY for India. With the help of DFLE, we can easily monitor health trends and examine disparity in health among different subgroups of the population.

In the present study we have defined disability in terms of the prevalence of reported ailments/diagnoses. Therefore, we have used interchangeably the terms ‘disability-free life expectancy’ (DFLE) and ‘ailment-free life expectancy’ (AFLE). Previous studies have found that life expectancy (LE) and healthy life expectancy (HLE) of women is higher among females than males, but the percentage of HLE to total LE is higher among men than women (Romero, Leite and Szwarcwald, 2005; Burgio, Murianni and Folino-Gallo, 2009; Cambois, Blachier and Robine, 2013; Tareque, Begum and Saito, 2013; Santosa et al., 2016; Moreno et al., 2018). However, very few studies in India tried to examine the above gender paradox (Thomas, James and Sulaja, 2014; Bora and Saikia, 2015). Therefore, in this chapter, our objective is to examine whether the gender paradox in health persists in India using the National Sample Survey (NSS) data of 2004 and 2017-18. Also, studies on the rural-urban disparity in DFLE are rare in the context of India. Hence, the present study also aims to investigate the difference in AFLE by place of residence.

HLE of a population is directly related to its mortality level and burden of disease. Recent studies suggest that “India is experiencing a rapid health transition, with large and rising burden of chronic diseases” (Reddy et al., 2005, p. 1744). For example, cases of ischemic heart disease in India have gone up from 18.6 million in 1998 to 22.4 million in

2004 (Upadhyay, 2012). The prevalence of diabetes in rural India is growing at a rate of 2.02 per 1000 population per year (Misra et al., 2011). However, communicable/infectious diseases are still persisting as significant health problems in India (Nongkynrih, Patro and Pandav, 2004). In this context, based on the prevalence of various ailments, we have also examined the age-specific burden of communicable and non-communicable diseases (NCDs) in India by sex and place of residence. This type of analysis is vital because appropriate policy measures depend on the information about the share of infectious diseases and NCDs in a particular age group.

In this chapter, we have estimated AFLE and the burden of infectious and non-communicable diseases of two different periods – 2004 and 2017-18. It helps us to examine the changes in AFLE and the prevalence of communicable and non-communicable diseases in India over the mentioned period. Policy decisions are required to be modified in accordance with the observed changes.

4.2. Methodology

We have applied the Sullivan method to estimate DFLE/AFLE, which combines morbidity and mortality data. Mortality related information needed for our analysis is collected from Sample Registration System (SRS) life tables of India for the periods 2002-06 (Office of the Registrar General, India, 2008) and 2014-18 (Office of the Registrar General & Census Commissioner, India, 2020). Information on morbidity has been computed from the unit level data of the 60th round and the 75th round of the National Sample Survey (NSS).

Mathematically Disability-Free Life Expectancy (DFLE) is expressed as:

$$e'_x = 1/l_x \sum_{x}^{w} (1- {}_n\pi_x)\, nLx$$

where e'_x = DFLE at age x; l_x = Number of survivors at age x; w = Oldest age category; nLx = Total number of person-years lived between exact ages x and x+n; ${}_n\pi_x$ = Prevalence of ailment between the ages x and x+n; and (1- ${}_n\pi_x$) = Age-specific rate of being healthy (disability-free)

The expected years of life in poor health= e_x - e'_x where e_x represents life expectancy at age x and e'_x represents DFLE at age x.

Whatever the health attributes chosen, the Sullivan model uses two separate and independent health measures: l_x and nLx for mortality and ${}_n\pi_x$ for morbidity components. To compute the prevalence of morbidity, we used the information on proportion ailing at a particular point of time (survey date). To obtain AFLE for the years 2004 and 2017-18, we applied statistics of proportion ailing by age and sex (and by age and place of residence) on SRS life tables of India for the periods 2002-06 and 2014-18, respectively. At the time of our analysis, the latest SRS-based abridged life table was available for 2014-18; so, we used it to estimate AFLE of 2017-18.

4.3. Results

4.3.1. Ailment-free life expectancy by sex: India, 2004 & 2017-18

In India, the average life expectancy at birth has increased from 49.7 years in 1970-75 to 69.4 years in 2014-18 (Office of the Registrar General & Census Commissioner, India, 2020). Also, the share of the elderly population, which was 5.6 per cent in 1961, is projected to increase to 12.4 per cent of the total population by 2026 (Central Statistics Office, Government of India, 2011). As longer life is associated with a greater load of chronic diseases, globally, public health researchers are paying more attention to the burden of diseases and economic and social consequences of illness than before. India is no exception.

Life expectancies and ailment-free life expectancies of males and females in India in 2004 are shown in Fig. 4.1. It is observed from Fig. 4.1 that both life expectancies and ailment-free life expectancies remained higher for women than men at any stage of life. However, the life expectancy curves show a wider gender difference than those showing ailment-free life expectancies. A similar trend was also found in 2017-18 (Fig. 4.2). It is because the reported morbidity rates were higher among females than males except for children and older adults (Appendices 4.1 to 4.4). The gender differences in LE and AFLE gradually converged towards old age.

Based on the literature review, some common hypotheses can be identified for women having a higher morbidity rate. "Women being more sensitive to their symptoms, more willing to articulate them and more willing to seek professional help... because women have more free time and fewer fixed role obligations, they are more likely than men to be in a position where they can adopt the sick role and manifest illness behaviour... the higher rates of morbidity in women are primarily attributable to the manifestation of higher rates of mild forms of physical illness" (Gove and Hughes, 1979, p. 144). The empirical study by Gove and Hughes (1979) supported the first and the third hypotheses but rejected the second. They found that women were much more likely to feel tense and anxious. Also, an excess of role demand partially accounted for why women had higher rates of physical illness. Their analysis reflected that sex differences in morbidity were real, but when marital status, living arrangements, psychiatric symptoms, and nursing role obligations were controlled, the health differences between men and women disappeared.

Fig. 4.1: Life expectancies and ailment-free life expectancies by sex: India, 2004

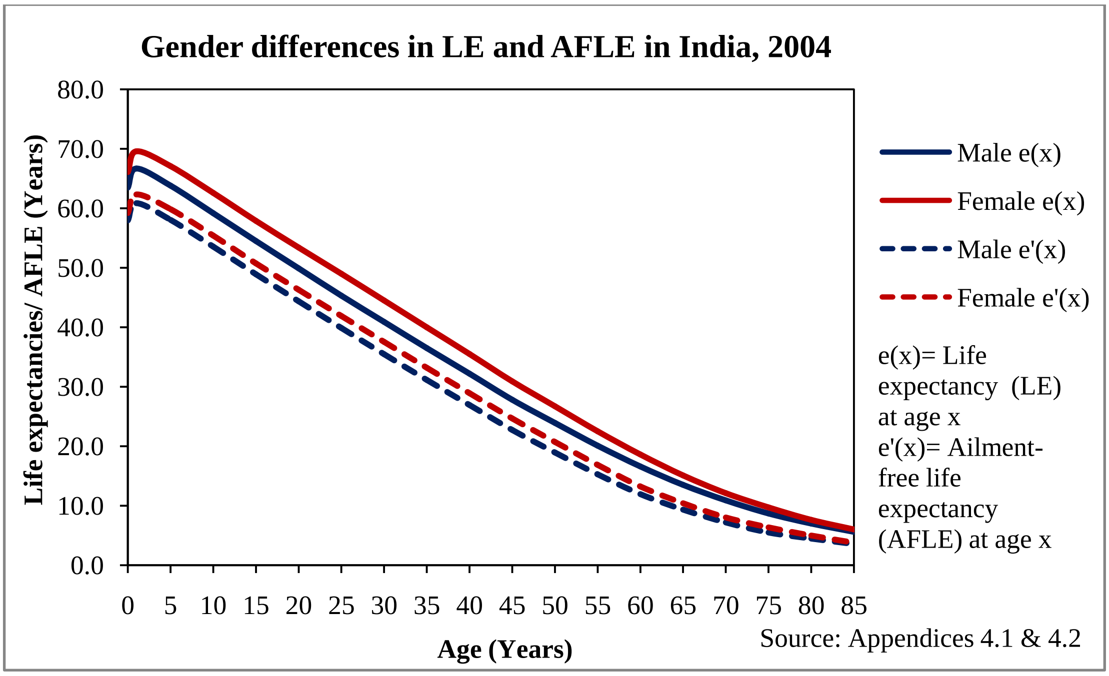
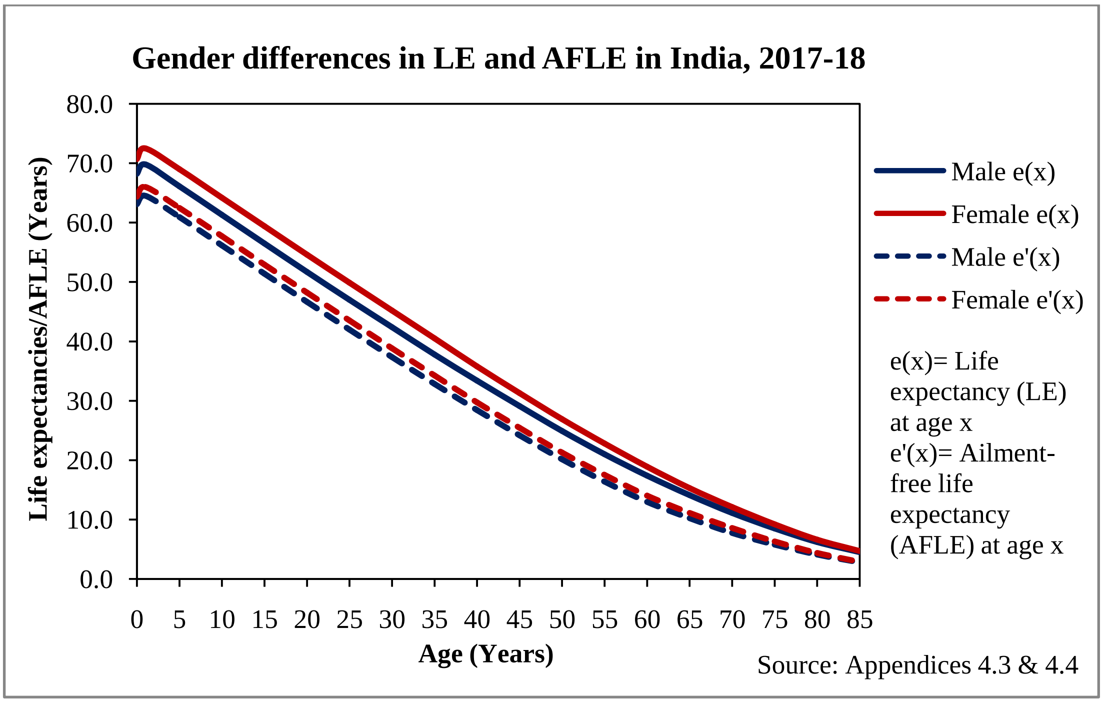


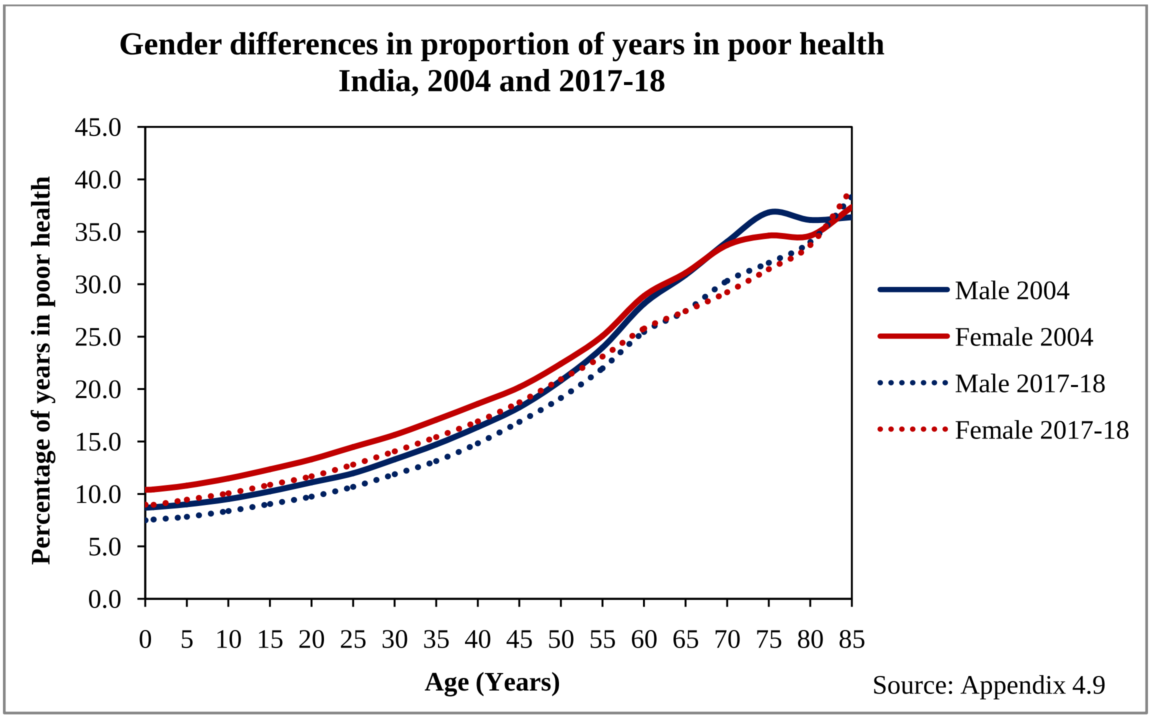
Fig. 4.2: Life expectancies and ailment-free life expectancies by sex: India, 2017-18



A more recent study by Emsile, Hunt and Mackintyre (1999) also revealed that women experienced significantly higher minor morbidity than men. However, in similar grades of employment and working conditions, the gender differences in illness turned out to be very small.

The general trend shows that females have higher LE and AFLE expectancy than males, but the proportion of life in poor health is higher among females. Our analysis found that females in India enjoyed higher LE and AFLE than males in 2004 and 2017-18. Now we will examine if the percentage of years lived in poor health is higher among females than males in India. The answer is crucial in understanding the gender difference in the quality of life and taking appropriate policy measures to eliminate such disparities. Fig. 4.3 represents the gender differences in the proportion of years under poor health to total life expectancy in India.

Fig 4.3: Proportion of years in poor health experienced by males and females in India, 2004 and 2017-18



Previous studies from India (Thomas, James and Sulaja, 2014; Bora and Saikia, 2015) observed that the number of years in poor health to total life expectancy was greater among females at any stage of life. In our study, the percentage of years in poor health was higher among men aged 70 to 84 in 2004 and 2017-18. However, the gender paradox in health sustained for the rest of the age groups. Our analysis shows that older men (70-84 years) were particularly vulnerable because not only their life expectancy and AFLE were lower than the females; they also spent a higher proportion of their life in disability compared to their female counterparts.

Except for the oldest age group (>85years), we observed a reduction in the proportion of years in poor health in India between 2004 and 2017-18. Such improvement was particularly prominent among the elderly below 80 years of age, irrespective of gender.

4.3.2. Ailment free life expectancy by place of residence: India, 2004 & 2017-18

In India, life expectancy is higher in urban areas than in rural areas. The rural-urban difference in life expectancies gradually decreases with increasing age (Office of the Registrar General & Census Commissioner, India, 2020). However, except for infancy and early childhood, AFLE was higher among the rural population than the urban population in India in both the years 2004 and 2017-18 (Fig. 4.4 and Fig. 4.5).

Fig. 4.4: Life expectancies and ailment-free life expectancies by place of residence: India, 2004

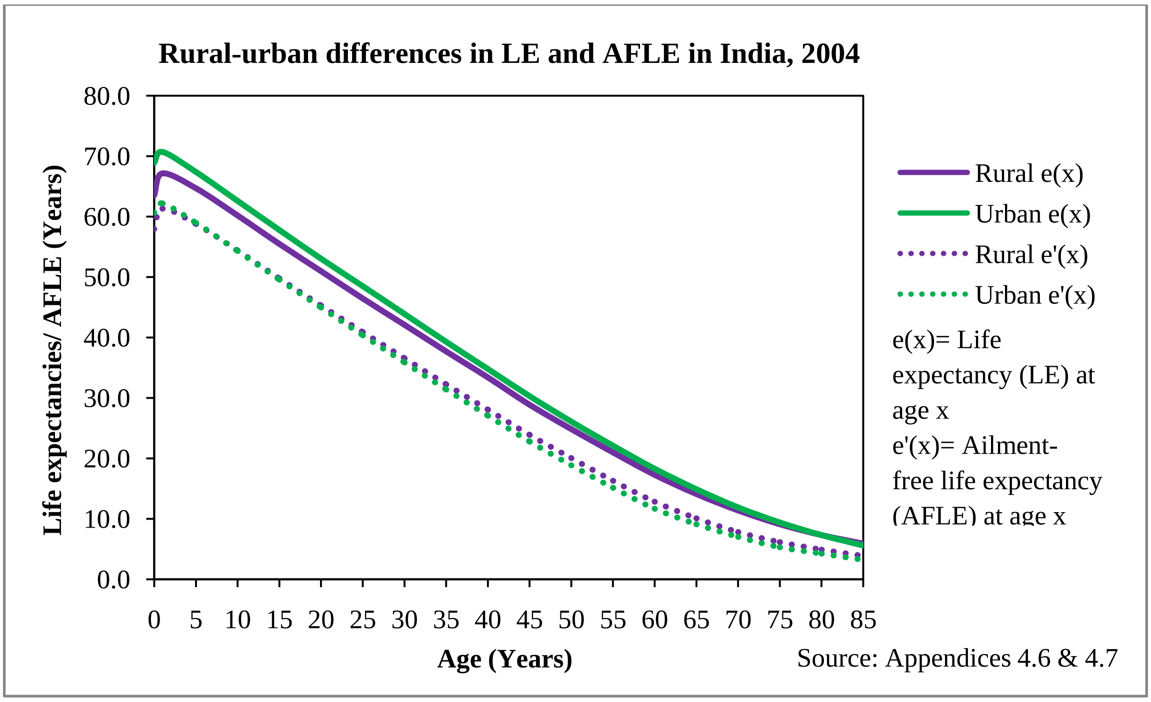
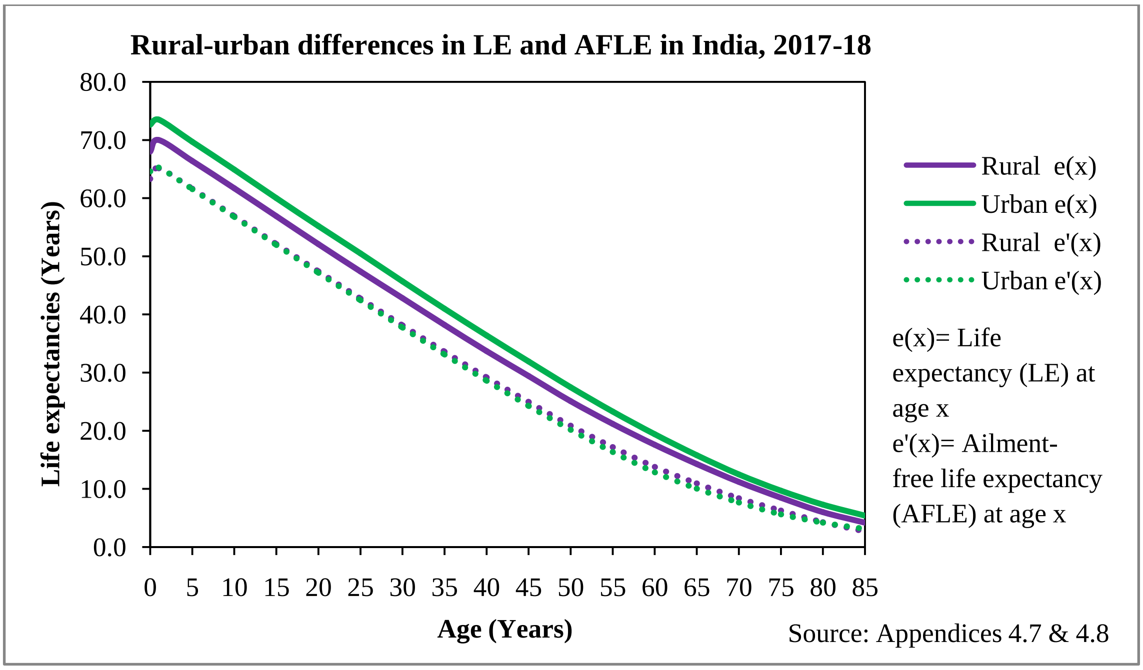


Fig 4.4 and Fig 4.5 indicate higher ailment among children in rural areas than urban areas. Lack of health care infrastructure in rural areas, lower access to health care due to poverty, lack of awareness regarding child health etc. can be sighted as the reasons behind it. After the initial years of life, reported ailment was found higher in urban areas.

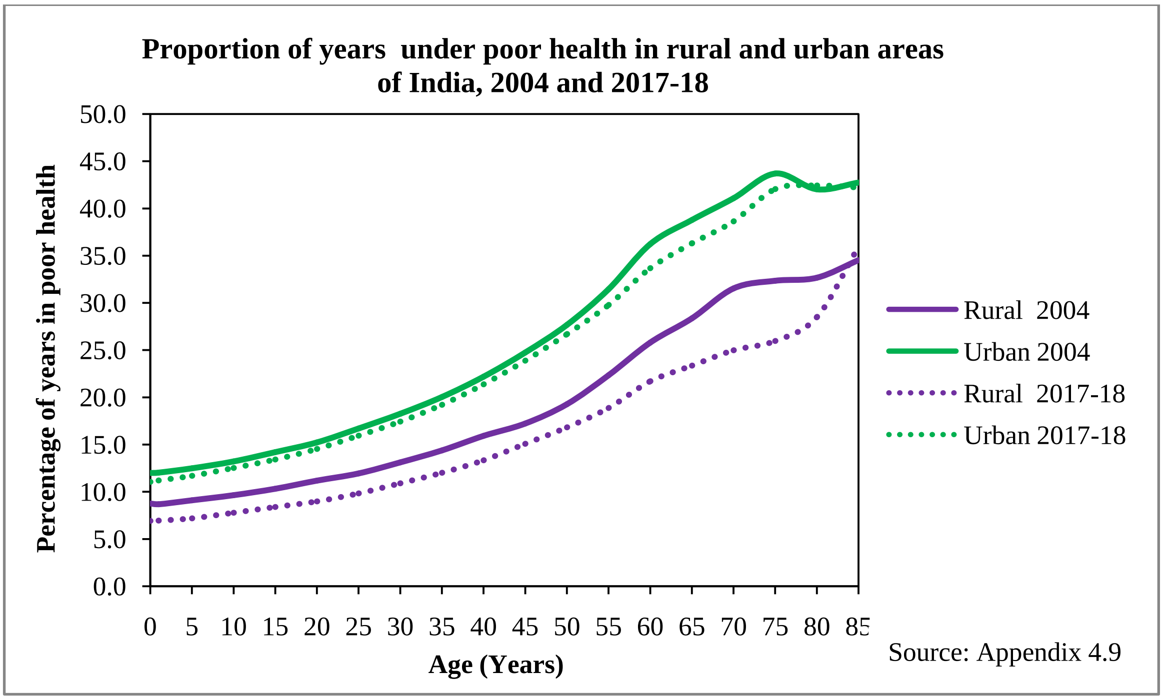
Fig. 4.5: Life expectancies and ailment-free life expectancies by place of residence: India, 2017-18



It is difficult to say whether a higher level of air pollution, contaminated drinking water and poor sanitation facilities in slum areas, presence of underprivileged migrant workers with high-risk behaviour, stressful life, lower level of physical activities etc. have contributed to higher morbidity rates in urban areas; or the reporting of ailment is lower in the rural areas as people are less aware/sensitive about their illness in rural areas and they have a lesser opportunity for the diagnosis of diseases compared to their urban counterpart. For a better and correct explanation, further empirical research is needed.

Fig 4.6 shows the proportion of years under poor health in rural and urban India. It was observed that the proportion of life in poor health reduced between 2004 and 2017-18, indicating improvement in the quality of life. The percentage of years in poor health to total life expectancy prevailed higher in urban areas among all the age groups. This trend was observed in 2004 and also in 2017-18 (Fig. 4.6). Therefore, we can deduce that the survival advantage of the urban population in India has not been translated into better health. The rural-urban gap regarding the proportion of years lived in poor health tend to increase with growing age. A wider rural-urban gap is found in 2017-18 than in 2004, particularly among the age group 60 to 80 years.

Fig 4.6: Rural-urban difference in the proportion of years under poor health in India, 2004 and 2017-18



4.3.3. The burden of communicable and non-communicable diseases in India by age and sex: 2004 and 2017-18

The 60th (2004) and the 75th round (2017-18) of NSS provide data on various ailments reported in the last 15 days preceding the surveys. Based on the information on disease prevalence, we computed ailment-free life expectancy in the previous section. Both communicable and non-communicable diseases (NCDs) and accidents/injuries contributed to total ailment. It is crucial to identify which age groups are more affected by a particular type of disease for effective health care intervention. However, the analysis of disease-specific morbidity by age groups is not possible with NSSO data as the sample sizes are very small for most diseases. Besides, the nature of ailment/reported diagnosis mentioned in the 60th and the 75th round are not the same. Therefore, we have identified the broad ailment types/groups (e.g., communicable diseases, non-communicable diseases etc.) of both rounds and analysed the age-specific burden of diseases in India by sex and place of residence.

We have grouped the various types of ailments reported in the 60th round of NSS into four broad categories, namely, (I) communicable/infectious diseases, (II) non-communicable diseases (NCDs), (III) accidents/injuries and (IV) other diagnosed & undiagnosed ailments. The GBDS also classified diseases and injuries under "three broad groups of causes: Group I, consisting of communicable diseases, maternal causes, conditions arising in the perinatal period, and nutritional deficiencies; Group II, encompassing the non-communicable diseases; and Group III, comprising all injuries, whether intentional or unintentional" (Murray and Lopez, 1996, p. 119). Unlike GBDS, we have put goitre**,** undernutrition and anaemia under the category of NCDs. In the present study, 'communicable/infectious' diseases include tuberculosis, hepatitis/jaundice, diarrhoea/dysentery, amoebiosis, worm infestation, mumps, conjunctivitis, diseases of skin, diseases of mouth/teeth/gum, respiratory disease, diphtheria, sexually transmitted diseases (STDs), filariasis/elephantiasis, malaria, fever of unknown origin, eruptive and whooping cough. The diseases that are categorised as 'non-communicable' are diabetes mellitus, gastritis/gastric/peptic ulcer, goitre, anaemia, cataract, heart disease, diseases of kidney/urinary system, asthma, psychiatric disorders, neurological disorders, hypertension, under-nutrition, joint and bone disorders, gynaecological disorders, prostatic disorders, glaucoma, tetanus, visual disability (excluding cataract), hearing disability, speech disability, locomotor disability, and cancers and other tumours. Accidents/injuries/burns/fractures/poisoning are put under the broad heading of 'accidents/ injuries'. Other undiagnosed and diagnosed diseases are considered as a separate category as 'others' for our analysis. Table 4.1 presents the decomposition of morbidity prevalence rates by ailment types for each age group in 2004.

Table 4.1: Age-specific morbidity prevalence rate by broad ailment types, India, 2004

Age groups	Prevalence rate (%)	Ailment type			
		Communicable diseases (%)	Non-communicable diseases (%)	Accidents/ injuries (%)	Others (%)
0-4	4.9	3.85	0.18	0.07	0.80
5-14	2.0	1.39	0.19	0.07	0.35
15-29	2.6	1.32	0.60	0.10	0.58
30-44	5.0	1.98	1.77	0.18	1.07
45-59	9.4	2.86	4.66	0.26	1.62
60-75	24.9	4.51	16.75	0.44	3.20
75 +	35.6	4.27	26.12	0.65	4.56
All ages	5.7	2.51	2.03	0.16	1.00

Source: Computed from unit level data of NSS, Round 60

It is observed from the above table (Table 4.1) that in 2004 the morbidity prevalence rate (point prevalence) was 5.7 per cent in India. The overall prevalence rate of infectious diseases (2.5 per cent) was higher than non-communicable diseases (2.0 per cent), although the prevalence of NCDs was distinctly higher among the elderly. The decomposition analysis pointed out that other diagnosed and undiagnosed ailments accounted for 1.0 per cent of total illness, which is considerably high. Their proper identification as infectious or non-infectious diseases may alter the prevalence rates of communicable and non-communicable diseases.

The nature of ailments given in the 75th round of NSS is more complex and detailed. The nature of ailment reported in this round can be categorised under five heads: (I) communicable diseases, (II) non-communicable diseases, (III) accidents/injuries, (IV) childbirth and (V) others. In our study, we have considered the following diseases as 'communicable': fever with loss of consciousness or altered consciousness, malaria, fever due to diphtheria and whooping cough, all other fevers (including typhoid, fever with rash/ eruptive lesions and fevers of unknown origin), tuberculosis, filariasis, HIV/AIDS, other sexually transmitted diseases, jaundice, diarrhoeas/dysentery/increased frequency of stools with or without blood and mucus in stools, worms infestation, discomfort/pain in the eye with redness or swelling/boils, earache with discharge/ bleeding from ear/infections, acute upper respiratory infections, cough with sputum with or without fever and not diagnosed as TB, skin infection (boil, abscess, itching) and other skin diseases, pain in pelvic region/ reproductive tract infections/pain in male genital area and diseases of mouth/teeth/gum. The symptoms/reported diagnosis that we have categorised under 'non-communicable diseases' are tetanus, cancers and occurrence of any growing painless lump in the body, anaemia, bleeding disorders, diabetes, under-nutrition, goitre and other diseases of thyroid, except the previous two other nutritional/metabolic/endocrine disorders (including obesity), mental retardation, mental disorders, headache, seizures or unknown epilepsy, weakness in limb muscles and difficulty in movements, stroke/hemiplegia/sudden loss of speech, other psychiatric & neurological disorders including memory loss and confusion, cataract, glaucoma, decreased vision (chronic), other eye problems including disorders of eye movements (strabismus, nystagmus, ptosis and adnexa), decreased hearing or loss of hearing, hypertension, heart disease that includes chest pain and breathlessness, bronchial asthma, gastric and peptic ulcer/acid reflux/acute pain in abdomen, lump or fluid in abdomen or scrotum, gastrointestinal bleeding, joint or bone disease/pain or swelling in any of the joints, back or body ache, any difficulty or abnormality in urination, and change/irregularity in menstrual cycle or excessive bleeding/pain during menstruation and any other gynaecological and andrological disorders including male/female infertility. The category 'accidents/ injuries' includes accidental injury, road traffic accidents and falls, accidental drowning and submersion, burns and corrosions, poisoning, intentional self-harm, assault and contact with venomous/harm-causing animals and plants. As 'childbirth' is not a disease but a physiological process, we have kept it as a separate category. Two items, ‘symptom not fitting into any above categories’ and ‘could not even state the main symptom’ together constitute the group ‘others’.

Table 4.2 shows the decomposition of age-specific morbidity prevalence rates by broad ailment types in India in 2017-18. It was observed that the morbidity prevalence rate (point prevalence) was 4.6 per cent in 2017-18 in India.

Table 4.2: Age-specific morbidity prevalence rate by broad ailment types India, 2017-18

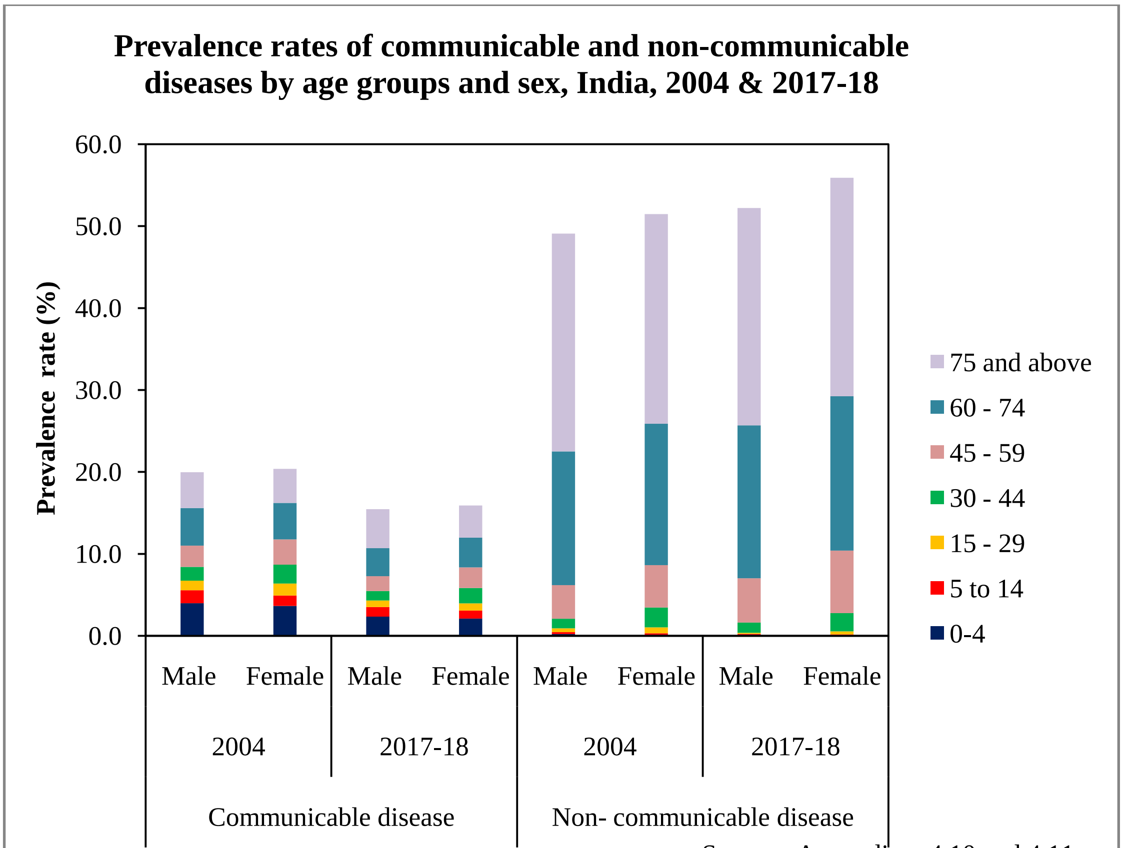
Age groups	Prevalence rate (%)	Ailment type				
		Communicable diseases (%)	NCDs* (%)	Accident /Injuries (%)	Others (%)	Child-birth (%)
0-4	2.4	2.27	0.11	0.01	0.01	0.00
5-14	1.2	1.07	0.10	0.02	0.01	0.00
15-29	1.1	0.81	0.24	0.02	0.03	0.01
30-44	3.4	1.53	1.76	0.06	0.04	0.00
45-59	8.8	2.16	6.49	0.10	0.06	0.00
60-75	22.7	3.52	18.70	0.14	0.34	0.00
75+	31.5	4.31	26.59	0.30	0.30	0.00
All ages	4.6	2.08	2.41	0.06	0.05	0.00

Source: Computed from unit level data of NSS, Round 75
*Non-communicable Diseases

We observed that the morbidity prevalence rate in India reduced from 5.7 per cent in 2004 to 4.6 per cent in 2017-18. During the 75^{th} round of NSS, the surveyors were provided with the working definitions of ailments/main symptoms. Therefore, the response on morbidity seems more accurate in the 75^{th} round. “In the 2004 survey and earlier surveys on health, persons with disabilities were regarded as ailing persons. In the 2014 and 2017-18 survey, pre-existing disabilities were considered as (chronic) ailments provided they were under treatment for a month or more during the reference period, but otherwise were not considered ailments” (Government of India, 2019, p-3). Together, these two factors may contribute to a lower prevalence of ailment in 2017-18 than in 2004. From table 4.2, we observed that in 2017-18, the prevalence of non-communicable diseases (2.4 per cent) exceeded the prevalence of infectious diseases (2.1 per cent) in India. One study from India also concluded that between 1990 and 2016, the proportion of DALYs attributed to NCDs and injuries increased, and the contribution of communicable diseases to DALYs decreased significantly (India State-level Disease Burden Initiative Collaborators, 2017). We found that the proportion of ailments categorised as ‘others’ to total ailment reduced considerably between 2004 and 2017-18. The reason can be attributed to the fact that the 75th round of NSS used a more comprehensive framework than the 60th round to identify reported ailment/main symptom.

Fig 4.7 shows the prevalence rates of infectious diseases and NCDs in different age groups by sex in India in 2004 and 2017-18. It is based on the decomposition analysis of age-specific morbidity prevalence rates by broad ailment types among males and females in India (Appendices 4.10 and 4.11).

Fig. 4.7: Prevalence rates (%) of communicable and non-communicable diseases by age groups and sex: India, 2004 and 2017-18



Source: Appendices 4.10 and 4.11

In 2004 and 2017-18, the burden of both communicable and non-communicable diseases was higher among females than males (Appendices 4.10 and 4.11). However, the prevalence rate of infectious diseases was higher among boys than girls below 15 years of age. The finding is not unexpected as researchers have pointed out that during infancy and childhood, girls enjoy some immunological advantage over boys in case of infectious diseases (WHO, 2007). In the age group 15 to 74 years, the burden of infectious diseases and NCDs was higher among women than men. Among the population 75 years and above, again, a higher prevalence rate of infectious diseases was observed among men.

There was a substantial increase in the burden of NCDs among the elderly between 2004 and 2017-18. For example, if the total disease burden among males in the age group 60-74 years is taken as 100 per cent, non-communicable diseases accounted for 66.9 per cent in 2004 and 82.9 per cent in 2017-18. The proportion increased from 67.7 per cent to 81.9 per cent among females. However, irrespective of gender, we found a slight reduction in the proportion of infectious diseases to total disease burden among the population aged 60-74 years. In contrast, the burden of infectious diseases increased slightly between 2004 and 2017-18 among the elderly 75 years and above.

4.3.4. The burden of communicable and non-communicable diseases in India by age and place of residence: 2004 and 2017-18

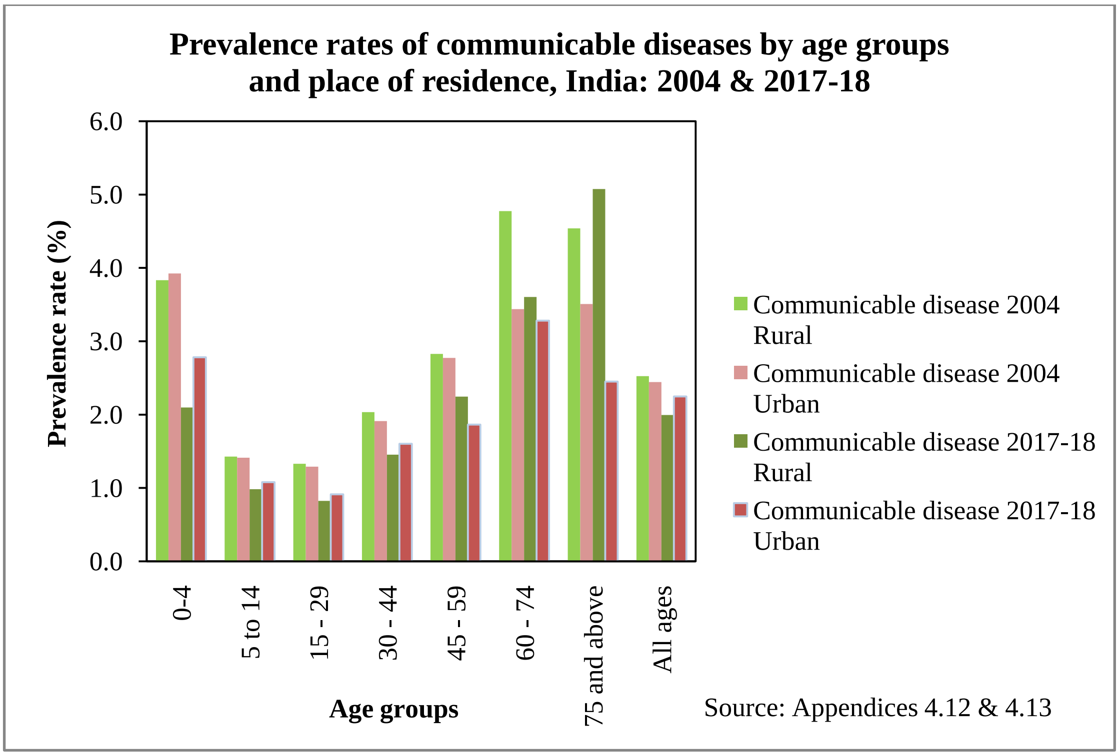
This section has analysed the differences in the burden of communicable and non-communicable diseases between rural and urban areas. A higher proportion of infectious disease to total disease burden was observed in rural areas, while people in urban areas experienced a higher proportion of non-communicable diseases. This trend was observed in 2004 as well as in 2017-18.

Several studies found that in India, the risk factors of NCDs, like physical inactivity and prevalence of diabetes, hypertension, and obesity, were much higher in urban areas than in rural areas (Aroor, Trivedi and Jain, 2013; Anjana et al., 2014; Oommen et al., 2016). Other countries also reported similar findings (Oyebode et al., 2015; Htet et al., 2016).

Fig 4.8 depicts the proportion of communicable diseases by age group and place of residence in 2004 and 2017-18 in India. Similarly, the proportion of NCDs by age and place of residence are shown in Fig. 4.9. Both the figures are based on the decomposition analysis of age-specific morbidity prevalence rates by broad ailment types in rural and urban areas (Appendices 4.12 and 4.13).

The reduction in the proportion of infectious disease to total disease burden between 2004 and 2017-18 was observed in each age group with one exception. The proportion of infectious diseases increased in the rural area among the age group 75 years and above. However, a remarkable reduction in communicable diseases was observed during this period among the children below five years of age, indicating improved health in this age group.

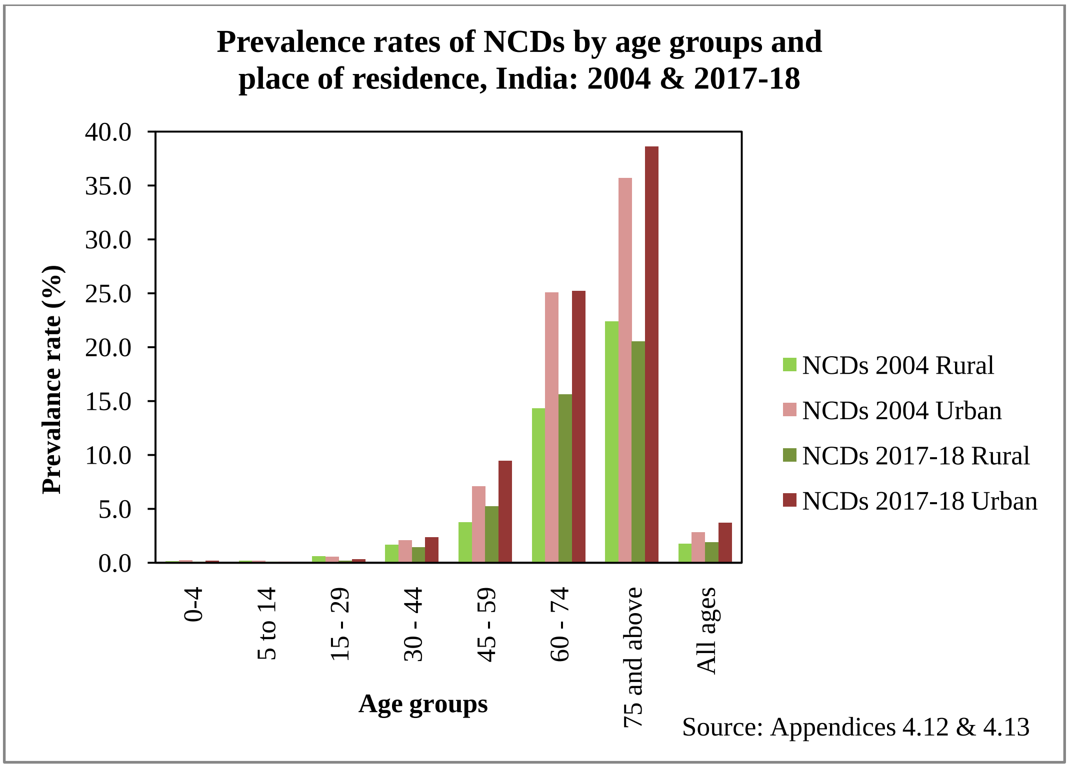
Fig. 4.8: Prevalence rates (%) of communicable diseases by age groups and place of residence: India, 2004 and 2017-18



In 2004, the ratio of infectious diseases to total disease burden was higher in rural India than in urban India except for the 0-4 year age group. In contrast, in 2017-18, a higher percentage of infectious diseases were observed among people below 45 years of age in urban areas. This finding requires a cautious interpretation and appropriate intervention by policymakers. In fact, between 2004 and 2017-18, the decline in the percentage of infectious diseases was much higher in rural areas than in urban areas among people below 45 years. Among the population 75 years and above, we observed a substantial rural-urban gap in the prevalence of infectious diseases. Actually, in this age group, the proportion of infectious diseases to total disease burden increased in rural areas between 2004 and 2017-18, but in urban areas, it declined, creating such difference.

A higher increase in the prevalence rates of NCDs was observed in urban areas than in rural areas between 2004 and 2017-18. The proportion of non-communicable diseases to total disease burden significantly increased in rural areas between 2004 and 2017-18 among the population aged 45 to 74 years. In urban areas, the population aged 45 years and above also reported a notable increase in the proportion of NCDs during this period. It indicates the ongoing epidemiological transition in India.

Fig. 4.9: Prevalence rates (%) of non-communicable diseases (NCDs) by age groups and place of residence: India, 2004 and 2017-18



We observed that the proportion of NCDs was conspicuously higher among the urban elderly than their rural counterparts. Therefore, reducing NCDs, particularly among the urban elderly, is a big challenge to the policymakers of India.

4.4. Conclusion

Gender paradox in health is observed in India with some exceptions. Although females enjoyed higher life expectancy and AFLE, they experienced a higher proportion of years in poor health to total life expectancy than males in most age groups. A higher percentage of life in poor health was reported by males aged 70 to 84 years in 2004 and 2017-18. Therefore, in India, we recommend that special attention be paid to the health care needs of older men (70-84 years) because their life expectancy with disability and proportion of life in poor health were higher than their female counterparts.

Our analysis demonstrates that higher life expectancy prevailed in urban areas in India in 2004 and 2017-18. However, AFLE was lower among the urban populations except for infancy and early childhood. Also, a higher proportion of years in poor health were observed among the urban population throughout their life course. Lower reporting of ailments in rural areas may contribute to the observed differences in AFLE between rural and urban India.

We found that both NCDs and communicable diseases have a substantial share in the total disease burden in India. While infectious diseases are the primary cause of morbidity in childhood, NCDs are the main cause of illness among older adults. However, because of antibiotic resistance and lower immunity power, the prevalence of communicable diseases at older ages is also substantial (Bijkerk et al., 2010). Therefore, a significant challenge lies ahead of India’s public health policymakers as they need to formulate a comprehensive road map to fight both communicable and non-communicable diseases. Only balanced policies and resource allocations can simultaneously reduce India’s burden of infectious and degenerative diseases.

Chapter 5

Healthy Life Expectancy (HLE) in India with particular reference to six states: An Analysis of World Health Survey, 2003

5.1. Introduction

Healthy life expectancy (HLE) is the average number of years expected to be spent in good health at a particular age, assuming fixed age-specific mortality and morbidity rates (Stiefel, Perla and Zell, 2010). It is an index that combines the estimates of mortality and disability into a single measure to assess population health (Robine and Ritchie, 1991). The concept of HLE is vital because living long is not enough; living a longer life with better health is what we prefer the most. Estimating HLE facilitates figuring out whether the rise in life expectancy is associated with the increase in the number of years with good health. Researches from developed countries revealed that the increase in the length of life in the past few decades was mainly experienced as the years of disability (McKinlay and McKinlay, 1979; Wilkins and Adams, 1983; Crimmins, Saito and Ingegneri, 1989). However, recent evidence of compression of morbidity from both the developed and developing world point out that the correlation between the increased life expectancy and the years in disability is a complex one (Jitapunkul and Chayovan, 2000; Liu et al., 2009; Fries, Bruce and Chakravarty, 2011; Zimmer, Hidajat and Saito; 2015). Recent development in genetic engineering and molecular biology shows the possibilities of delayed ageing that can increase both the life expectancies and the proportion of life in good health at older ages (Beltrán-Sánchez, Soneji, and Crimmins, 2015; Harari, 2017).

For the computation of HLE, one can use various parameters of health. In this context, first, we should define the term ‘health’. According to World Health Organization (WHO), “health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (WHO, 1946). Therefore, ailment-free life (AFL) is only one aspect of healthy life. Prevalence or incidence of health-related occurrences are numerous and measure different aspects of health. The World Health Survey (WHS), 2002-2004, conducted by the World Health Organization in collaboration with 70 countries, provides information on various dimensions of health such as the respondent’s perception about overall health status, activity limitation and functional health (which involves social, psychological and physical domains of health). Therefore, WHS data on self-rated health

(SRH) and self-reported disabilities (SRD) was widely used to depict the population's health status in various countries.

Although self-rated health is essentially subjective and contextual depending on socioeconomic status, health conditions of similar age peers, culture etc. (Tissue, 1972; Baron-Epel, 2005), it is irrefutable that the basis of rating lies in the biological and psychological condition of the individuals (Jylha, 2009). Further, it is often not feasible for a researcher, particularly in developing countries, to get the information of medically diagnosed illness or disability. In such cases, they must rely on the respondents' reporting about a disease or general health (Suchman, Phillips and Streib, 1958). Several studies found that SRH is a reliable predictor of clinical outcome and mortality of a population (Idler and Benyamini, 1997; Cousins, 1997; Fayers and Sprangers, 2002; DeSalvo et al., 2006; Lima-Costa et al., 2012). Based on extensive literature review, it is found that the measure of self-rated health based on a five-point scale "has demonstrated stability, consistency and good test-retest reliability and is strongly related to a wide set of health outcomes, including general morbidity, reported symptoms, health care utilisation and mortality" (Hardy, Accai and Reyes, 2014, p. 320). Self-reported disabilities (SRD), like activity limitation and functional limitation, often corroborate the performance-based disability of a person (Merrill et al., 1997). Therefore, SRH and SRD are frequently used to measure healthy life expectancy and disability-free life expectancy, respectively (Romero et al., 2005; Jeune and Bronnum-Hansen, 2008; Gu et al., 2009; Cambois, Blachier and Robine, 2013; Tareque et al., 2014; Bora and Saikia, 2015; Santosa, 2016; Jia and Lubetkin, 2020). However, studies on HLE using self-rated health and DFLE using self-reported disabilities have recently gained momentum in India. Singh et al. (2013) studied the male-female differences in SRH among the older population in India using the data of NSSO Round 60. Their study revealed that after covariate adjustment, a higher percentage of women reported poor SRH than men. Similar findings were reported by several other studies (Roy and Chaudhuri, 2008; Dhak, 2009; Panday and Ladusingh, 2015; Oksuzyan et al., 2018)

In another study, using the data of the Longitudinal Ageing Study in India (LASI), Pilot Survey, 2010, Arokiasamy, Uttamacharya, and Jain (2015) found that functional health and poor SRH were positively associated with multi-morbidity among adults aged 45 and above. Based on the 2007 WHO Study on Global Ageing and Adult Health in India, Bora and Saikia (2015) observed that women were more likely to report poor SRH and had higher life expectancy with disability than men after adjusting social, economic, and demographic factors.

In continuation with the ongoing researches, in the present chapter, we have computed HLE in India based on the data on perceived health state obtained from the WHS-India, 2003. The main objective of our study is to compare the estimated healthy life expectancies as derived from self-rated general health, self-reported activity limitations and self-reported functional limitations (involving social, psychological and physical domains of health). We have also compared ailment-free life expectancy (AFLE) derived from the data of the National Sample Survey, Round 60, to understand if AFLE can be used as a substitute for HLE. Previous studies from India did not attempt this type of comparative analysis. As WHS-India, 2003 covered six states in India, another objective of our research is to analyse the inter-state variation in healthy life expectancies based on self-rated health.

5.2. Methodology

The World Health Survey conducted in India in 2003 covered six major states, namely, West Bengal, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, and Assam. The selection criteria of the states and the details of sample design are available in the report "Health System Performance Report: World Health Survey, 2003, India" (Arokiasamy et al., 2006). As the above six states covered almost half of the population in India, we have pooled the data of these states for all India level analyses. The survey covered 10279 households. The questionnaire on health information covered a total sample of 9994 individuals aged 15 years and above. It is assumed that children cannot rate their health state properly; therefore, children were excluded from the interview.

Using the data of WHS-India, 2003, we have estimated healthy life expectancies considering different aspects of health. In the first case (Case 1), we have estimated HLE based on self-rated general health. Here, the respondents were requested to rate their overall health status on the day of the survey. The answers were available on a five-point Likert scale: 'very good', 'good', 'moderate', 'bad' and 'very bad'. Then we dichotomised the responses as 'poor self-rated health' combining 'bad' and 'very bad' and 'good self-rated health' combining the other answers. The age-specific prevalence rates (ASPR) of poor health were used to compute healthy life expectancies at various ages (Appendix 5.1). When we subtract the ASPR of poor health from 1, we get the age-specific prevalence rate of being healthy.

In the second case (Case 2), the estimation of HLE was based on activity limitation. The respondents were asked the question, "Overall, in the last 30 days, how much difficulty did you have with work or household activities?” The responses were provided on a five-point Likert scale: ‘none’, ‘mild’, ‘moderate’, ‘severe’, and ‘extreme/cannot do’. The reactions were pooled to obtain two categories: ‘activity with difficulties’, which combined the responses ‘severe’ and ‘extreme/cannot do’ and ‘activity without difficulties’, which combined the other responses. In this case, the calculation of HLE was based on the proportion of individuals in each age group who performed the activities with difficulty (Appendix 5.2). By subtracting the proportion from 1, the age-specific rate of being healthy is obtained.

In the third case (Case 3), the estimation of HLE was based on the severity of functional limitations involving the social, psychological and physical domains of health. “The International Classification of Functioning, Disability and Health (ICF)” has classified functioning as an essential component of health and defined functioning as an umbrella term for body functions, body structures, activities and participation (WHO, 2001). Considering the multidimensional aspect of functioning, the World Health Survey in India included 16 questions to capture an individual’s health. The questions were grouped under eight domains. The following table (Table 5.1) presents an overview of the health domains and questions regarding functional difficulties.

Table 5.1: Health domains and questions regarding functional difficulties

Health Domains	Questions regarding functional difficulties
Mobility	“Overall in the last 30 days, how much difficulty did you have with moving around? In the last 30 days, how much difficulty did you have in vigorous activities, such as running 3 km (or equivalent) or cycling?
Self-care	Overall in the last 30 days, how much difficulty did you have with self-care, such as washing or dressing yourself? In the last 30 days, how much difficulty did you have in taking care of and maintaining your general appearance (e.g. grooming, looking neat and tidy etc.)?
Pain and discomfort	Overall in the last 30 days, how much of bodily aches or pains did you have? In the last 30 days, how much bodily discomfort did you have?
Cognition	Overall in the last 30 days, how much difficulty did you have with concentrating or remembering things?

	In the last 30 days, how much difficulty did you have in learning a new task (for example, learning how to get to a new place, learning a new game, learning a new recipe etc.)?
Interpersonal activities	Overall in the last 30 days, how much difficulty did you have with personal relationships or participation in the community? In the last 30 days, how much difficulty did you have in dealing with conflicts and tensions with others?
Vision	In the last 30 days, how much difficulty did you have in seeing and recognising a person you know across the road (i.e. from a distance of about 20 meters)? In the last 30 days, how much difficulty did you have in seeing and recognising an object at arm's length or in reading?
Sleep and energy	Overall in the last 30 days, how much of a problem did you have with sleeping, such as falling asleep, waking up frequently during the night or waking up too early in the morning? In the last 30 days, how much of a problem did you have due to not feeling rested and refreshed during the day (e.g. feeling tired, not having energy)?
Affect	Overall in the last 30 days, how much of a problem did you have with feeling sad, low or depressed? Overall in the last 30 days, how much of a problem did you have with worry or anxiety?"

Source: (WHO, 2002) Individual Questionnaire, World Health Survey, 2002

These domains are incorporated in several popular health status-related surveys such as the Short Form 36 (SF 36), the Euroqol 5D, and the Health Utilities Index Mark 3 (HUI 3) (Moussavi et al., 2007). A composite score was computed based on the answers to the 16 questions on functional health. Since the item responses were based on a five-point ordered categorical scale ('none'=1, 'mild'=2, 'moderate'=3, 'severe'=4, and 'extreme/cannot do'=5), factor analysis was done using the principal component method to obtain factor score. The analysis was performed with the help of SPSS version 22. The score in the first principal component was transformed to a (0, 1) scale using the formula [(Score-minimum)/(Maximum-Minimum)], where 0 corresponds to the best health (without any functional limitation), and 1 indicates the worst health. The proportion of disability by age group was calculated as the arithmetic means of the scale's value in that age group. The rate of being healthy is derived by subtracting that value from 1. Appendix 5.3 shows the healthy life expectancy at various ages, estimated by considering the continuum of severity of functional limitations involving social, psychological and physical health domains.

In Chapter 4, we estimated AFLE based on the National Sample Survey, Round 60 (2004) data. As ailment-free life is an essential attribute to a healthy life, we have compared AFLE with WHS findings in this chapter. We followed the Sullivan method to estimate HLE/AFLE, which has already been described in the previous chapter. In the present analysis, we have used the age-specific proportion of poor health/disability on Sample Registration System (SRS) life tables of India and selected states for the period 2001-2005.

Like mortality rate, the prevalence rate of poor health is affected by the age structure of any population. We have also estimated the age-standardised prevalence rate (ASPR) of poor health for comparison purposes.

5.3. Results

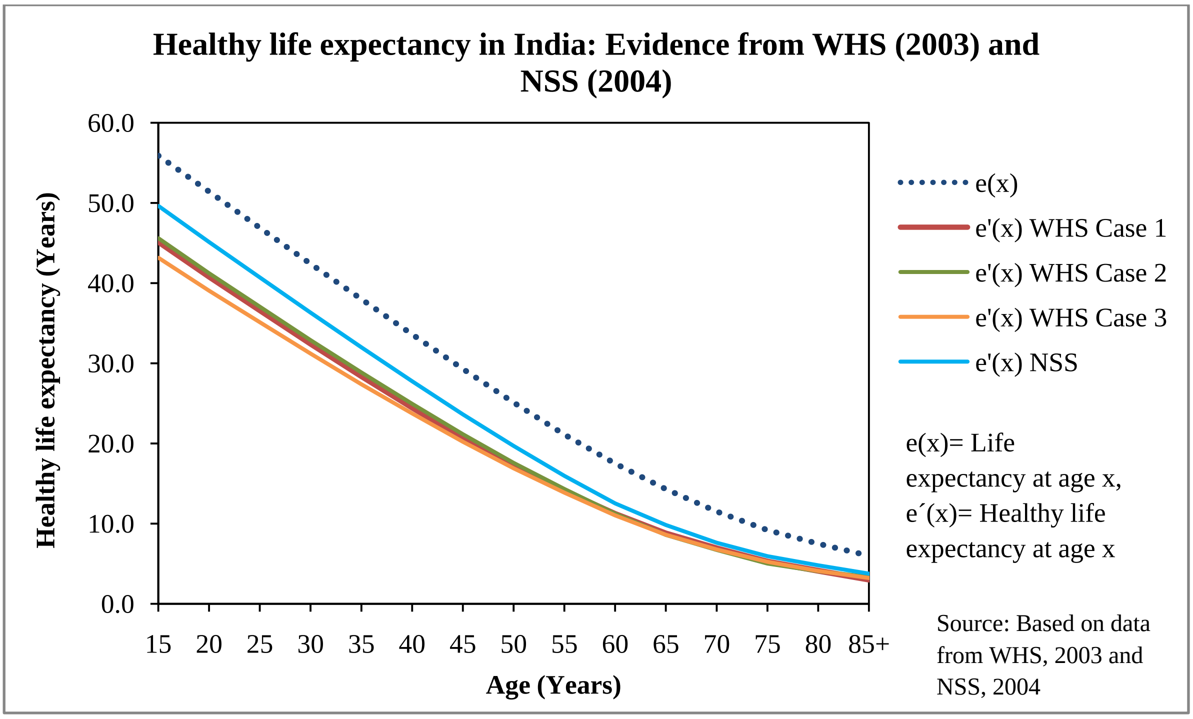
5.3.1. Healthy life expectancy in India based on three different aspects of health

Fig. 5.1 shows HLE in India based on self-rated general health, self-reported activity limitations and self-reported functional health. For comparison purposes, ailment-free life expectancies derived from NSS, Round 60 is also added to this diagram. It is found from Fig. 5.1 that AFLE were higher at various ages than HLE measured through other dimensions of health. Healthy life expectancies derived from the information on general health and activity limitations produced almost similar results (Case 1 and Case 2). Healthy life expectancies in Case 3 based on multidimensional aspects of health were lower than in other cases. However, after age 65, the differences in healthy life expectancies derived involving different dimensions of health were minimised.

The above findings were also applicable for both the males and females in India in 2003.

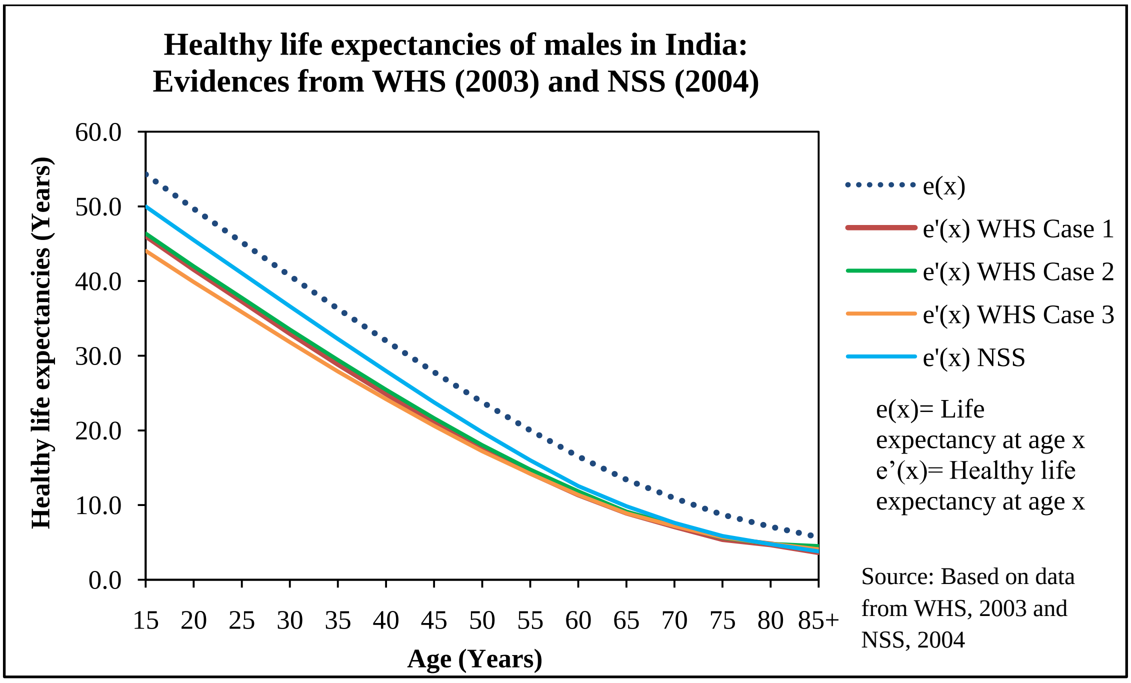
Analysing the data of WHS-India (2003), it is apparent that not much difference exists in healthy life expectancies measured by three different dimensions of health, particularly among older adults. Therefore, healthy life expectancies based on self-rated general health can be used as a proxy to HLE estimated involving functional health or activity limitations. Our results also indicate that the general health state should not be interpreted in terms of the prevalence of diseases only.

Fig. 5.1: Healthy life expectancies by different aspects of health: India



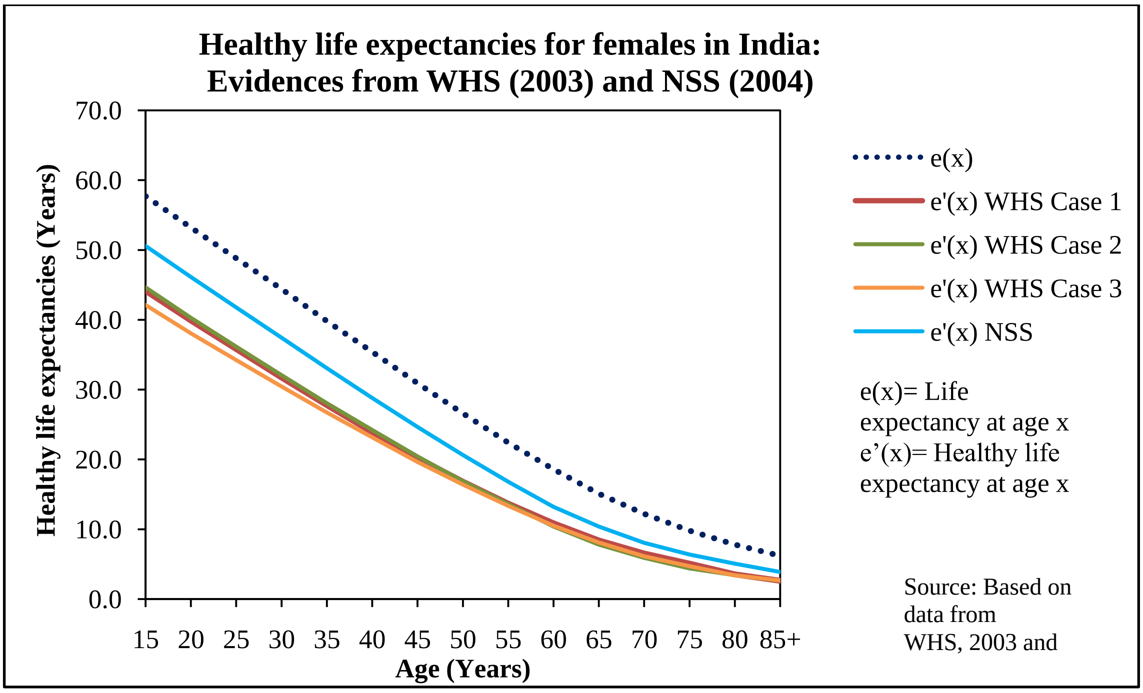
Note: Case 1: Self-rated general health, Case 2: Self-reported activity limitation, and Case 3: Self-reported functional limitations involving social, psychological and physical domains of health

Fig. 5.2: Healthy life expectancies in India by different aspects of health: Male



Note: Case 1: Self-rated general health, Case 2: Self-reported activity limitation, and Case 3: Self-reported functional limitations involving social, psychological and physical domains of health

Fig. 5.3: Healthy life expectancies in India by different aspects of health: Female

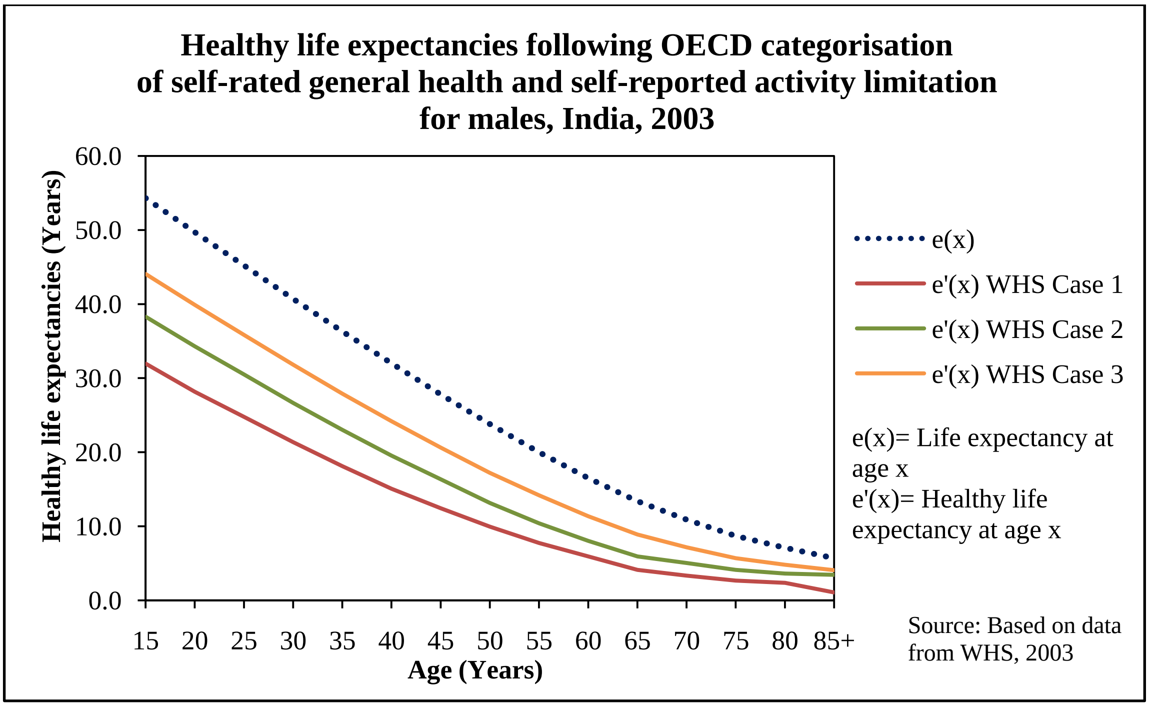


Note: Note: Case 1: Self-rated general health, Case 2: Self-reported activity limitation, and Case 3: Self-reported functional limitations involving social, psychological and physical domains of health

At this point, it should be mentioned that in our study in Case 1 (self-reported general health), we considered the responses of ‘very good’, ‘good’, and ‘moderate’ as good health. Previous studies from Brazil and India also used similar categorisation (Romerro, Leite and Szwarcwald, 2005; Arokiasamy, Uttamacharya and Jain, 2015). In Case 2 (activity limitation), we considered ‘none’, ‘mild’ and ‘moderate’ difficulties in work as the indicator of good health. On the other hand, healthy life expectancies given for the OECD countries were based on the percentage of the population who reported their health to be good/ excellent (Case 1) and who said none or mild difficulties in work (Case 2) (OECD Health Statistics, 2014). Fig 5.4 shows the graphical representation of healthy life expectancies of males in India (2003), applying the OECD categorisation of good health.

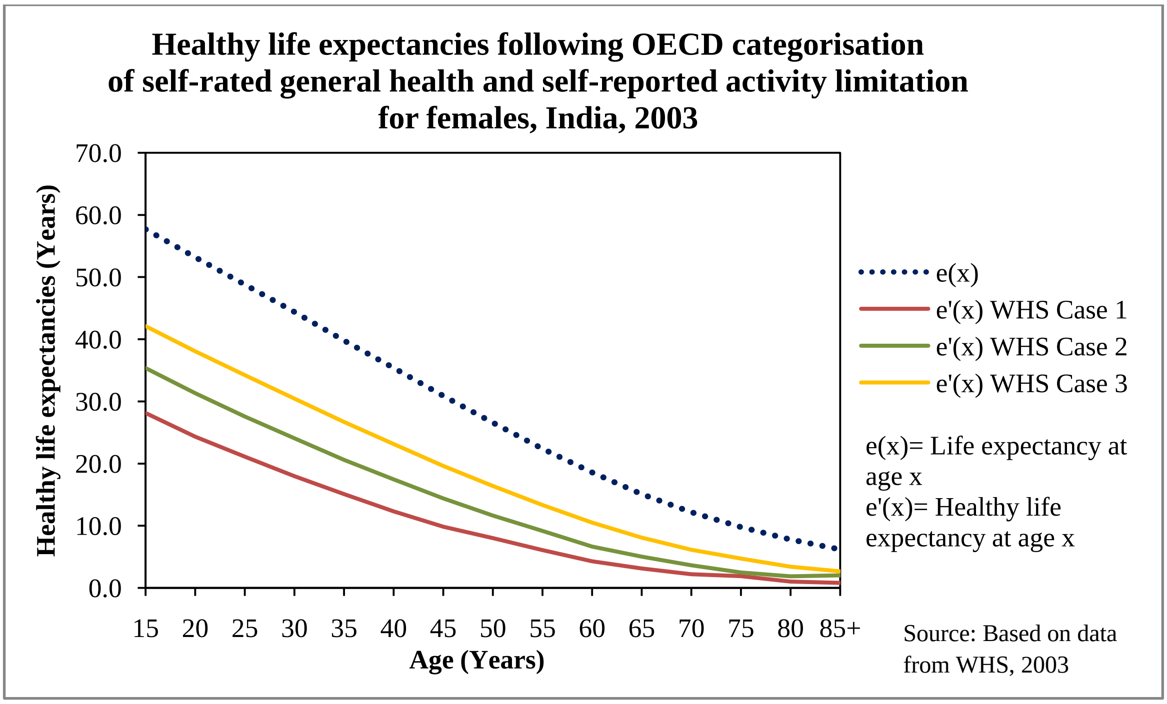
Following OECD categorisation of good health, significant differences are observed in HLE measured by self-rated general health (Case 1), self-reported activity limitations (Case 2) and self-reported functional limitations (Case 3). At age 15, male HLE for cases 1, Case 2 and Case 3 were 32.0 years, 38.3 years and 44.1 years, respectively (Appendix 5.6). At age 60, the respective HLE were 5.9 years, 8.0 years and 11.4 years.

Fig. 5.4: Healthy life expectancies (following OECD categorisation) in India: Male



Note: Case 1: Self-rated general health, Case 2: Self-reported activity limitation, and Case 3: Self-reported functional limitations involving social, psychological and physical domains of health

Fig. 5.5: Healthy life expectancies (following OECD categorisation) in India: Female



Note: Case 1: Self-rated general health, Case 2: Self-reported activity limitation, and Case 3: Self-reported functional limitations involving social, psychological and physical domain of health

So, if we follow the OECD categorisation, significant differences arise in healthy life expectancies measured by three different dimensions of health. Also, HLE in Case 1 and Case 2 fall much below the HLE in Case 3. Similar trends were also observed for females (Fig. 5.5, Appendix 5.7).

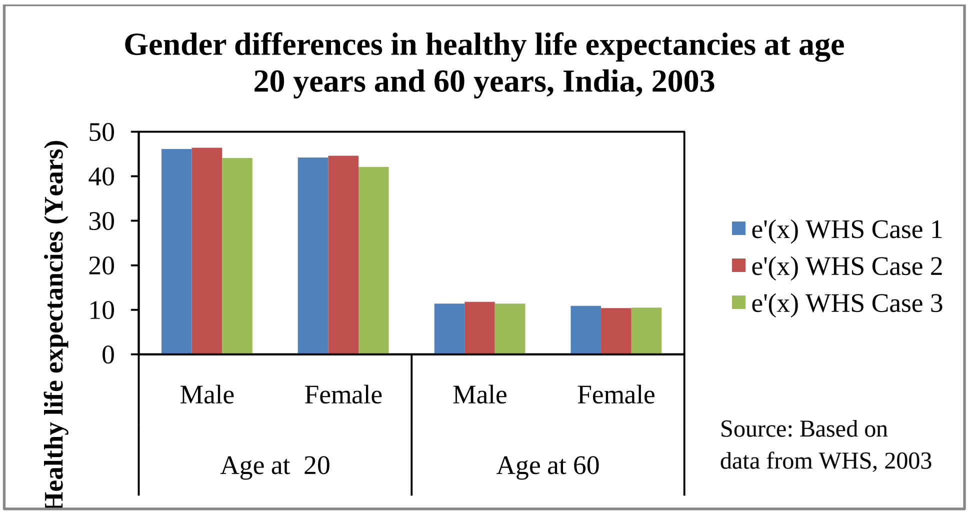
Therefore, it is not wise to follow the OECD categorisation of good health for India. Our categorisation of good health differs from OECD categorisation as different cultures have their own frameworks for health evaluations (Jylha, 2009). According to Zola (1966), cultural patterns of experiencing and reporting bodily symptoms were well recognised in health sociology. In his study in Massachusetts (1960-1961), he found that for the same diagnosis, the Italian patients complained of more symptoms, more bodily areas affected, and more kinds of dysfunctions than did the Irish patients.

5.3.2. Male-female and rural-urban differences in healthy life expectancies as revealed by WHS-India, 2003

Now let us look at the gender differentials in HLE based on different aspects of health (Case 1: Self-rating of general health, Case 2: Self-reporting on activity limitation, and Case 3: Functional health involving social, psychological and physical domains). Although the differences are minimal, healthy life expectancies were lower among the females in all three cases than males (Appendices 5.4 and 5.5). Fig. 5.6 shows that at age 20 and 60, healthy life expectancies for females were slightly lower than males. However, in the previous chapter, we found that ailment-free life expectancies were higher among females than males in most cases. The above discrepancy can be explained by the fact that HLE encompasses many things apart from being ill such as the psychological condition of a person.

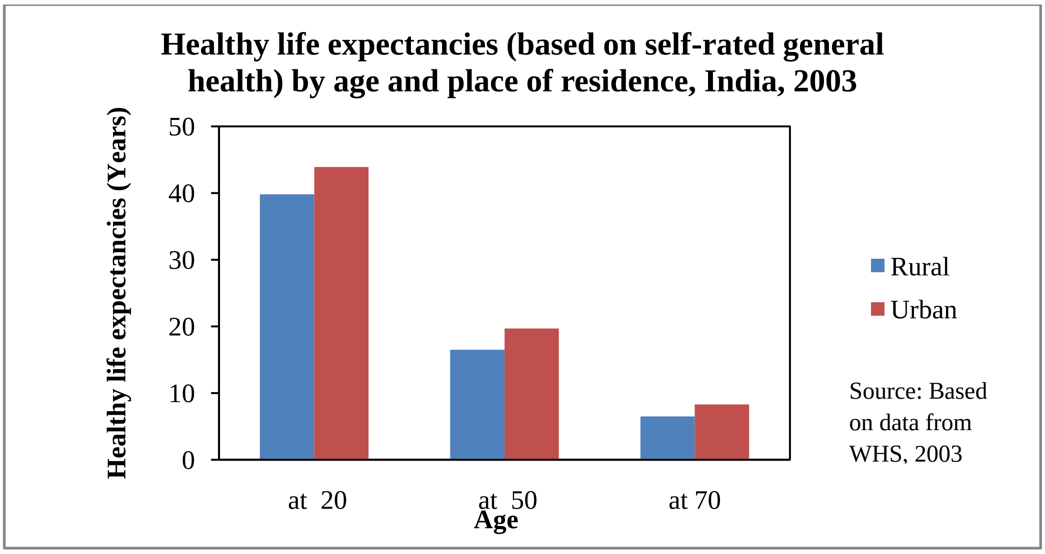
In the case of rural-urban differentials in HLE, we observed that both life expectancies and HLE (estimated from the information on self-rated general health, i.e., Case 1) were higher in urban areas than in rural areas (Appendix 5.8, Fig. 5.7). On the other hand, analysing the data of NSS, 2004, we found that life expectancy was higher in urban areas, but ailment-free life expectancy was higher in rural areas. It can be argued that HLE based on self-rated general health considers the broader aspect of health than AFLE. Further, cultural differences in urban and rural areas on the perceptions of ‘health’ and ‘illness’ may contribute to the observed differences in HLE between rural and urban areas.

Fig. 5.6: Gender differentials in healthy life expectancies in India, 2003



Note: Case 1: Self-rated general health, Case 2: Self-reported activity limitation, and Case 3: Self-reported functional limitations involving social, psychological and physical domains of health

Fig 5.7: Healthy life expectancies by age and place of residence, India, 2003



5.3.3. HLE and burden of disease in six large states in India

In this section, using the information on self-rated general health (Case 1), we have estimated healthy life expectancies for six large states of India: West Bengal, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, and Assam. In India, the WHS was conducted in these six states in 2003.

At first, let us look at the respondents' rating of general health on the survey date (Table 5.2).

Table 5.2: Respondents' rating of general health on the date of the survey in six states of India, 2003

States	Per cent distribution				
	Very good	Good	Moderate	Bad	Very bad
Assam	26.3	50.5	14.8	6.7	1.7
Karnataka	44.7	39.1	11.5	3.5	1.1
Maharashtra	13.4	38.9	33.4	11.5	2.8
Rajasthan	22.9	32.4	23.8	16.0	4.9
Uttar Pradesh	28.0	27.7	25.9	15.8	2.5
West Bengal	6.0	29.9	38.8	19.8	5.5

Source: Computed from the unit level data of WHS-India, 2003
Note: The percentages are calculated using sample weights

It is interesting to note that in Karnataka, a large share of the population (44.7 per cent) have reported their health as 'very good'. In contrast, in West Bengal, only 6.0 per cent of respondents rated themselves in a 'very good' health state. The highest proportion of the population who rated their health as 'good' were from Assam (50.5 per cent), followed by Karnataka (39.1 per cent) and Maharashtra (38.9 per cent). Among the study states, the highest reporting of 'moderate', 'bad' and 'very bad' health was observed in West Bengal.

If we look at the overall prevalence rate of poor health (which includes the responses of 'bad' or 'very bad'), West Bengal recorded the highest percentage (25.3 per cent), followed by Rajasthan (21.0 per cent) and Uttar Pradesh (18.4 per cent). Since the age structure of these states was different, a direct comparison of the rates may be misleading (Srinivasan, 1998). For example, the proportion of population 60 years and above were 5.8 per cent in Assam, 6.6 per cent in Uttar Pradesh, 6.7 per cent in Rajasthan, 7.5 per cent in West Bengal, 8.1 per cent in Karnataka and 8.6 per cent in Maharashtra in 2006 (Office of the Registrar General and Census Commissioner, India, 2006). For controlling the impact of age structure, we have used the direct standardisation technique taking the population of India as standard. The age-standardised prevalence rate (ASPR) of the poor health of six Indian states has been shown in Table 5.3.

Like crude prevalence rates, standardised prevalence rates present a general summary picture. Apart from Rajasthan, the ASPR of poor health is smaller than crude prevalence rates (Table 5.3). After controlling for the age, we observed that the difference in the prevalence rates of poor health between the states has changed; for example, the gap between Assam and West Bengal in ASPR is smaller than the crude prevalence rate.

Table 5.3: Comparison between crude prevalence rates and age-standardised prevalence rates of poor health in six states of India, 2003

States	Crude prevalence rate of poor health (%)	Age-standardised prevalence rate of poor health (%)
Assam	8.4	7.3
Karnataka	4.7	4.1
Maharashtra	14.3	12.1
Rajasthan	18.4	19.9
Uttar Pradesh	21.0	16.9
West Bengal	25.3	21.9

Source: Computed from the unit level data of WHS-India, 2003

Using the information on the prevalence rate of poor health, we have also estimated healthy life expectancies of six states under study (Appendix 5.9). Like the national level analysis, 'poor health' was calculated by combining the responses of 'bad' and 'very bad' health. Table 5.4 shows the variation in LE and HLE among the states at age 20, 40 and 60 years. The highest life expectancy (LE) was observed in Maharashtra, but the highest healthy life expectancy was estimated for Karnataka. Assam and West Bengal recorded the lowest life expectancy and HLE, respectively. The maximum difference in life expectancies (6.2 years) was recorded between Maharashtra and Assam at age 20. On the other hand, the maximum difference in HLE (12.5 years) was observed between Karnataka and West Bengal at age 20. At age 60, the difference between LE and HLE was only 1.9 years in Karnataka, while in the case of West Bengal and Rajasthan, the difference was 8.5 years and 8.1 years, respectively.

Table 5.4: Life expectancies and healthy life expectancies by age in six states of India, 2003

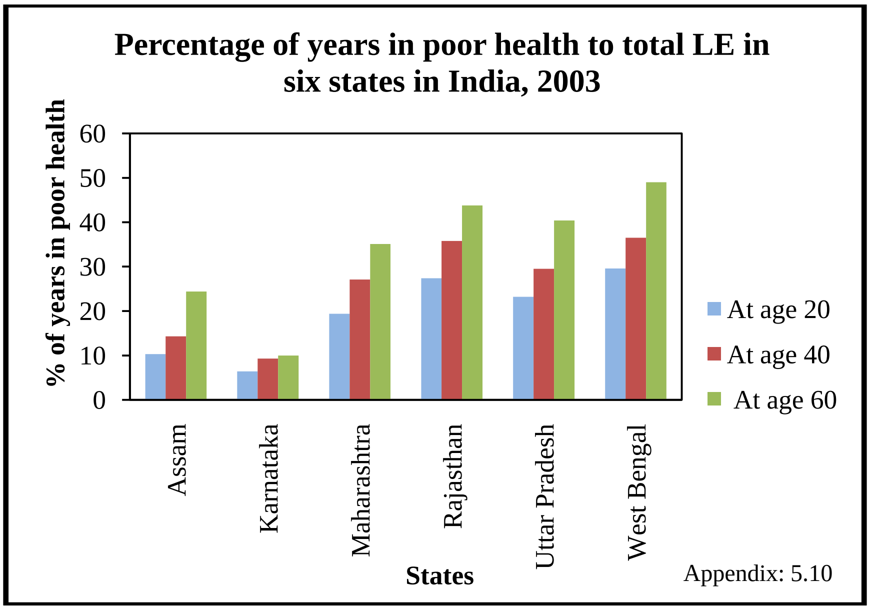
States	Age 20		Age 40		Age 60	
	LE	HLE	LE	HLE	LE	HLE
Assam	47.0	42.2	29.7	25.4	14.6	11.1
Karnataka	52.6	49.3	34.9	31.6	19.0	17.1
Maharashtra	53.2	42.9	35.4	25.8	19.2	12.5
Rajasthan	53.1	38.5	35.0	22.4	18.4	10.3
Uttar Pradesh	50.0	38.4	32.8	23.1	17.0	10.1
West Bengal	52.3	36.8	33.9	21.3	17.3	8.8

Source: Computed from the unit level data of WHS-India, 2003, and
The SRS Life Tables of respective states of India, (2001-05)

Note: LE-Life expectancy, HLE- Healthy life expectancy

Fig. 5.8 and Appendix 5.10 show the percentage of life in poor health at age 20, 40 and 60 for the six states under study. The proportion of life in poor health to total life expectancy was higher at age 60, as older persons are more prone to illness than young persons. Among six states, the highest and the lowest percentage of years in poor health to total LE were observed in West Bengal and Karnataka, respectively. In Karnataka, the proportion of life in poor health at age 20 was less than 10 per cent, but in West Bengal, it was almost 30 per cent. At age 60, a person was expected to spend more than 40 per cent of his/her remaining life in poor health in West Bengal, Rajasthan and Uttar Pradesh. On the other hand, in Karnataka, the proportion of years in poor health to the LE at age 60 was only 10 per cent.

Fig. 5.8: Percentage of life in poor health to total life expectancy in six large states of India, 2003



Why did a very low proportion of people in Karnataka report poor health? Is it because the reporting of morbidity was lower in Karnataka, or did the state have much higher achievement in the health sector than other states? According to NFHS-3 (2005-06), among the six states, Karnataka showed the best performance regarding antenatal care, deliveries assisted by health personnel and post-natal check-up (IIPS and Macro International, 2007). These factors can be related to the better health conditions of women and consequently higher reporting of good health in Karnataka. The performance of Maharashtra regarding the indicators mentioned above was also close to Karnataka. Moreover, compared to Karnataka, Maharashtra showed better performances regarding many health-related indicators: percentage of households with toilet facilities and improved source of drinking water, and infant mortality rate (IIPS and Macro International, 2007; Registrar General of India, 2006). Yet, the percentage of expected years in poor health was remarkably higher in Maharashtra compared to Karnataka. Even the percentage of years in poor health to life expectancy at age 60 was 1.5 times higher in Maharashtra than in Assam, one of the most backward states in India. Analysing the data of the 60^{th} round of NSS (2004), we found that the morbidity prevalence rate was the lowest in Assam (3.4 per cent), followed by Karnataka (3.8 per cent) and the highest morbidity prevalence rate was observed in West Bengal (10.4 per cent). It indicates that as self-rating of health is subjective to some extent, the population of Karnataka and Assam rated their health more positively than West Bengal, Maharashtra, Uttar Pradesh and Rajasthan.

However, the report on the "World Health Survey, 2003: India" (Arokiasamy et al., 2006) revealed some morbidity and health system performance-related facts of these states that should be mentioned while analysing the disparity in self-rated health. It was found that among the six states, the percentage of the population treated for common NCDs (diabetes, arthritis, asthma, angina, depression and psychosis) was very high in Karnataka. In fact, the percentage of people receiving treatment for diabetes, arthritis and psychosis was the highest in Karnataka (96.1 per cent, 72.8 per cent and 85.2 per cent, respectively). In the case of angina, the highest percentage of people was treated in Assam (88.6), followed by Karnataka (78.6). The WHS identified "seven domains of health system responsiveness that addresses the concerns of people seeking health care" (Arokiasamy et al., 2006). These were autonomy, choice, communication, confidentiality, dignity, quality of basic amenities (such as clean surroundings, clean water etc.) and prompt attention. The highest mean score of the respondent's ratings in the case of both in-patient and out-patient services was observed in Karnataka. The maximum number of medical colleges in India is also located in Karnataka (Ministry of Health and Family Welfare, 2018). The competition among the hospitals also brings down the health care expenditure. The government of Karnataka launched Yeshasvini Health Insurance Scheme as early as 2003 designated for the farmers who are members of the state co-operative societies. Data shows that Karnataka had the highest number of allopathic doctors, general nurses, midwives and auxiliary nurse midwives per 100,000 populations in 2002 (Arokiasamy et al., 2006). On the other hand, in West Bengal, the number of doctors was almost half, and the number of general nurses and midwives was nearly a third of Karnataka. One study observed that in West Bengal "public health delivery system is crippled by several constraints: vacancies and absenteeism of staff; urban/rich bias in the distribution and use of facilities; lack of drugs and other essential supplies at the field level and low staff motivation and management capacity" (Rana and Mishra, 2012, p. 1 of 6). When we look into the government expenditure on health, we find that Karnataka recorded the highest per capita public health care expenditure in 2004-05 (Rs. 233). In West Bengal, it was Rs. 173 (National Health Accounts Cell, Government of India, 2009). In fact, with growing fiscal deficit and state public debt, the budgetary allocation in health declined in West Bengal from 6.0 per cent in 1999-2000 to 3.9 per cent in 2003-04 (Rana and Mishra, 2012). If people can afford and access treatment for diseases and have a sound and sensitive health care system, that definitely positively influences the health status of any population. Moreover, WHS found that the monthly household health expenditure was the minimum in Karnataka among the six states. We can assume an inverse relationship exists between reporting of 'good' self-rated health and monthly household expenditure on health.

As we have calculated both AFLE and HLE for India, one may be curious about the AFLE of the six states under study. Therefore, we have also estimated AFLE for those six states (Table 5.5).

Table 5.5: Ailment-free life expectancies in six large states in India, 2004

Age (Years)	Assam	Karnataka	Maharashtra	Rajasthan	Uttar Pradesh	West Bengal
0	55.4	60.9	60.8	60.6	55.3	58.7
1	59.0	63.5	62.2	65.0	59.4	60.5
5	56.6	60.2	59.0	62.5	57.4	57.4
10	52.4	55.4	54.3	58.0	53.0	53.0
15	47.8	50.6	49.6	53.4	48.4	48.3
20	43.4	46.0	45.1	48.8	44.0	43.7
25	39.0	41.4	40.5	44.3	39.8	39.2
30	34.7	36.9	36.1	39.8	35.6	34.8
35	30.3	32.5	31.7	35.5	31.5	30.4
40	26.0	28.1	27.4	31.1	27.5	26.1
45	21.7	23.8	23.2	26.9	23.4	21.9
50	17.8	20.0	19.3	22.9	19.7	18.1
55	13.9	16.0	15.5	19.2	16.1	14.2
60	10.3	12.3	11.9	15.5	12.8	10.8
65	7.5	9.4	9.4	12.4	10.2	8.5
70	5.5	6.9	6.9	9.8	8.0	6.5
75	3.6	5.4	5.2	7.7	6.3	5.1
80	3.5	4.8	3.9	5.8	5.1	4.2
85+	2.2	4.0	2.6	4.0	4.1	3.7

Source: Computed from the unit level data of NSS, Round 60, and
The SRS Life Tables of respective states of India, (2002-06)

At birth, the highest AFLE was observed in Karnataka and the lowest in Uttar Pradesh. At age 60, Rajasthan experienced the highest AFLE, followed by Uttar Pradesh and Karnataka. The lowest AFLE at age 60 was found in Assam, followed by West Bengal. Our analysis reveals that, at the state level, substantial variation is observed between HLE (based on self-rated general health) and AFLE. For example, at age 20, HLE and AFLE were 36.8 years and 43.7 years, respectively, in West Bengal. The variation was smaller at age 60. At age 60, HLE was higher than AFLE in three states, namely, Assam, Karnataka and Maharashtra.

5.4. Conclusion

In conclusion, we can say that in India, when we dichotomise the responses of self-rated health into ‘poor’ and ‘good’, we should combine the responses of ‘very good’, ‘good’ and ‘moderate’ to get the category of good self-rated health for India. With such categorisation, healthy life expectancy measured by self-rated general health can be a good proxy to HLE measured by activity limitations or functional health involving social, psychological, and physical health domains. Our categorisation of good health differs from OECD categorisation. Such difference can be explained by the role of culture in shaping responses to pain and suffering (Gureje et al., 1998; Jylha, 2009; Hardy, Acciai and Reyes, 2014). Linguistic factors also play a role; for example, in standard translations to Spanish and Russian, the middle option average or fair indicates normal health (Jylha, 2009). In India, also, the general connotation for moderate health seems to be normal health.

We have estimated HLE in India based on self-rated general health, self-reported activity limitations and self-reported functional health. We found that healthy life expectancies, measured by all the three aspects of health, were higher among the males, although life expectancies were higher among the females. The works of Saikia and Bora (2015) corroborates our findings. Both LE and HLE were higher in urban areas than in rural areas. Our results suggest that women and rural people need special attention from public health policymakers.

Finally, we compared healthy life expectancies of six large states of India, namely, West Bengal, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, and Assam. We observed the highest healthy life expectancy in Karnataka and the lowest in West Bengal. Inter-state variation in government’s health policy, public health expenditure, health care infrastructure, accessibility and affordability of health care in the state, health system responsiveness, state-specific cultural connotation of poor health and pain etc., were responsible for the observed differences in HLE among the states. As a result, compared to the life expectancy, a higher inter-state disparity in healthy life expectancy was observed in India.

Chapter 6

Socioeconomic inequality in healthy life expectancy in India

6.1. Introduction

Like the regional disparity in health, socioeconomic inequality in health is a major concern for public health policymakers. Why should we bother about the inequalities in health across socioeconomic groups? One of the reasons is that it is undesirable if we find a significantly higher infant mortality rate among the poor than the rich or among the tribes than the non-tribal population. It points to the fact that the differences in health outcomes are the consequences of historically evolved discriminatory social structures (Peter, 2006). From our childhood, we have learnt that health is wealth because health is related to well-being, and it improves people's ability to function. Now, suppose one group systematically suffers from poor health than others. In that case, the group members continue to lag behind in society, trapped by the vicious cycle of poverty and malnutrition. In this situation, per capita equal health expenditure may not bring similar benefits to all groups. Studies on socioeconomic inequality in health help the government identify the marginalised section and thus, prioritise its resource allocation. The allocation of more funds to fulfil the health requirements of the underprivileged groups offers a greater possibility for improving the average health standard of any society (Mackenbach et al., 1997). In this context, it is crucial to analyse the socioeconomic inequalities in health in India so that appropriate policy measures can be adopted to improve the health conditions of disadvantaged groups.

The impact of socioeconomic status (SES) on mortality has been widely studied worldwide. Data and reports from the past showed that mortality due to epidemics and famine were higher in the lower social classes (Cipolla and Zanetti, 1972 cited in Mackenbach, 2002). Since the 1980s, substantial research has been done to study socioeconomic inequality in mortality and morbidity in industrial and developing nations. Numerous studies considered mortality and morbidity separately and assessed how they varied with socioeconomic status (SES) in a population (Marmot, Shipley and Rose, 1984; Blane, Bartley and Smith, 1997; Mackenbach and Kunst, 1997; Smith et al., 2003; Ghosh and Kulkarni, 2004; Szwarcwald et al., 2005; Subramanian, Smith and Subramanyam, 2006; Mackenbach et al., 2008; Huguet, Kaplan and Feeny, 2008; Pradhan and Arokiasamy, 2010; Saikia and Ram, 2010; Ataguba, Akazili and Mclntyre, 2011; Hosseinpoor et al., 2012; Biswas et al., 2016; Saikia, Bora and Luy, 2019; Mishra et al., 2019; Kumar et al., 2021).

Besides, several studies dealt with socioeconomic inequalities in health as revealed by summary measures of population health (Sullivan, 1971; Wilkins and Adams, 1983; Mathers, Vos and Stevenson, 1999; Melzer et al., 2000; Bossuyt et al., 2004; Hidajat, Hayward and Saito, 2007; Camargos, Machado and Rodrigues, 2007; Huguet, Kaplan and Feeny, 2008; Majer et al., 2011; Ataguba, Akazili and Mclntyre, 2011; Zimmer, Hidajat and Saito, 2015; Bora and Saikia, 2015; Lu et al., 2018).

Bhan, Rao and Kachwaha (2016) have reviewed the issues of health inequality research in India since the 1990s. They concluded that the focus has shifted from the socioeconomic inequality by mortality and infectious and chronic diseases to NCDs, injuries, risk factors, and mental health. Recently two studies (Luhar et al., 2018; Corsi and Subramanian, 2019) analysing the National Family Health Survey (NFHS) data of various rounds pointed out that the burden of diabetes, hypertension and obesity was higher among the higher SES groups in India. Many studies captured disparity in health care utilisation by socioeconomic groups in India (Kopparty, 1994; Joe, Mishra and Navaneetham, 2008; Lauridsen and Pradhan, 2011; Singh et al., 2012; Prakash and Kumar, 2013; Goli and Arokiasamy, 2014). Mahal, Karan and Engelgau (2010) analysed the socioeconomic inequality regarding health care expenditure. Bora and Saikia (2015) observed that self-rated health varied across socioeconomic groups in India. However, studies on the socioeconomic inequality in healthy life expectancy (HLE) are rare in India, mainly due to the lack of data.

In this chapter, our main objective is to examine the socioeconomic inequality in HLE in India to fill this gap. As the estimation of HLE is based on both morbidity and mortality indicators, it represents a comprehensive picture of the population's health status in any society. Besides, we have also analysed the determinants of poor health reporting in India.

6.2. Methodology

To estimate healthy life expectancy, we have calculated the age-specific death rates (ASDR) by socioeconomic groups from the second National Family Health Survey (NFHS-2) conducted in India in 1998-99. However, NFHS-2 did not provide the necessary data to compute the morbidity prevalence rate in India. Therefore, we have used information on morbidity from the World Health Survey conducted in India (WHS-India) in 2003. As morbidity is the state of being unhealthy or symptomatic for a disease or condition (Hernandez and Kim, 2020), we have defined morbidity rate in the present study in terms of the percentage of people who perceived their health state as 'poor' on the survey date. We assumed that poor health represents the state of being unhealthy. The respondents who rated their health as ‘bad’ or ‘very bad’ were considered as persons having ‘poor health’. The health condition is designated as ‘otherwise’ for those who rated their health as ‘moderate’, ‘good’ and ‘very good’. Among 9994 individuals who completed the interview, 1642 person reported their health state as ‘poor’.

Although the World Health Survey-2003 was conducted in India after four years of the field survey of NFHS-2, it is the nearest large scale population survey in India after NFHS-2. Between 1998 and 2003, the death rate in India declined from 9.0 to 8.0 per 1000 (Registrar General, India, 2014). We presume that, like mortality, there would not be significant differences in self-rated health among the Indians between 1998 and 2003.

Before estimating healthy life expectancy, we have done the bivariate analysis showing the percentage of people reporting poor health by socioeconomic groups. The socioeconomic groups have been selected in terms of education, wealth index, and religion, depending on data availability. However, the results after covariate adjustment are more refined and preferable. Therefore, we have estimated the predicted probability of poor health by different socioeconomic groups in India. The estimation of predicted probabilities is derived from the results of binary logistic regression. In logistic regression, if a person reported poor health, it is coded as ‘1’ and ‘0’ if otherwise. Below we have discussed the methodology to calculate predicted probabilities from logistic regression.

The basic form of logistic regression is

$P = 1/ (1+ e^{-Z})$ where P is the estimated probability (here, the likelihood of reporting poor health by the respondent), Z is the predictor variable, and e is the base of natural logarithm with a value of 2.7183.

Or, $P = e^{Z} / (1+ e^{Z})$

Or, $1 – P = 1/ (1+e^{Z})$

Or, $P/ (1 – P) = (1+e^{Z}) / (1+ e^{-Z}) = e^{Z}$

Taking the natural log of the above equation we have

$\text{Logit}(P) = \ln \{P / (1 – P)\} = Z$

The quantity $P / (1 – P)$ is called the odds; hence the quantity $\ln \{P / (1 – P)\}$ is called the log of odds or the logit of P.

Also, $Z = \beta_0 + \beta_1X_1 + \beta_2X_2 + \ldots\ldots\ldots\ldots+\beta_kX_k$

where $X_{1,}$ $X_{2,}$ X_3…Xk is the independent or predictor variables (for example, sex, level of education, religion, wealth status etc.) and β_1, $\beta_{2,}$… β_k are the regression coefficients.

In the next level of calculation, odds are proportionally adjusted according to a weight for each level of the confounding factors.

Adjusted odds are calculated as

$$A_{ij} = \ln [p/(1-p)] - [(\sum_j n_{ij} * b_{ij}) / \sum_j n_{ij}] + b_{ij}$$

Where n_{ij}= Number of cases in category j of variable i

b_{ij}=Estimated logit regression coefficient for category j of variable i

p= Overall probability (for the entire population)

Finally, predicted probability for category j of factor i = exp (A_{ij})/[1+exp(A_{ij})]

In the next section of this chapter, we have estimated healthy life expectancy by socioeconomic groups. The calculation of healthy life expectancy was similar to disability-free life expectancy. We have already discussed the methodology to estimate DFLE in Chapter 4.

6.3. Results

6.3.1. Socioeconomic inequality in perceived health state: Evidence from WHS-India, 2003

The socioeconomic status of a population group is usually measured in terms of occupation, income and education (Feinstein, 1993). However, a considerable number of studies are available which analysed health inequality by race or caste (Sullivan, 1971; Crimmins, Saito and Ingegneri, 1989; Hayward and Heron, 1999; Chang, Nocetti and Rubin, 2005; Subramanian et al., 2008; Jungari and Chauhan, 2017; Dutta et al., 2020). We have selected the socioeconomic groups by level of education, wealth quintile and religion. As World Health Survey was conducted simultaneously in several countries, it did not include the caste variable as it is a characteristic feature of India only. Although levels of education and wealth quintile have a strong correlation, each has its own distinct influence on health. Education provides better employment opportunities and earnings that help people to access better health care services. Besides, education enables a person to make informed choices and overcome vulnerability and marginalisation, which indirectly allows a person to attain better health care (Dreze and Sen, 2002). Educated persons are more conscious about their health problems and more aware of unhealthy behaviours. Wealth directly influences access to education, nutritious food and better medical facilities. Poor people are more likely to have a low level of education, work in unhealthy conditions, stay in dirty and polluted neighbourhoods, engage in risky health behaviours and suffer from higher mental stress.

Mothers of low-income groups have a greater likelihood of having low birth-weight babies who are caught in the cycle of poverty and report a higher rate of illness in their adulthood. Therefore, health status varies by level of education and wealth index. We have also analysed the perceived health status of the population in India by religion because different religions have different social norms and cultural practices that may directly or indirectly influence a person's health. Religion can affect women's health through "norms related to fertility and family planning practices" (Shabnam, 2016, p. 31). Table 6.1 shows the percentage of people who reported poor health by socioeconomic groups.

Table 6.1: Percentage of people who reported poor health by socioeconomic groups, India, 2003

Background Characteristics		% reported poor health	N	Total	P-value
Level of education	No education or below the primary	23.3	1120	4861	
	Primary completed	14.6	259	1752	<.001
	Secondary completed	10.7	133	1318	
	Completed HS or higher	5.9	130	2063	
Religion	Hindu	14.8	1214	8065	<.001
	Non-Hindu	21.0	428	1929	
Wealth quintile	Poorest	19.8	427	2006	
	Poorer	19.2	391	1996	
	Middle	16.1	324	2004	<.001
	Richer	14.9	254	1995	
	Richest	12.0	225	1993	

Source: Computed from the unit level analysis of WHS-India, 2003
Note: Percentages are calculated using sample weights
P-value is based on Pearson's Chi-square test

It is evident from table 6.1 that in India in 2003, the prevalence rate of poor health was four times higher among those who had no education/below primary level education than those who completed higher secondary. In the case of religion, the proportion of the population who reported poor health was 1.4 times higher among the non-Hindus than the Hindus. To understand health inequality based on the wealth index, we have compared the poorest and the richest groups' health conditions. We found that compared to the richest group, the percentage of people who reported poor health was 1.7 times higher among the poorest category.

Table 6.2 shows the percentage of people reporting poor health by demographic, health-related and regional characteristics. Following the population health model of Evans and Stoddart (1990), the factors that influence the health of a person were considered in our study. Besides the socioeconomic variables (level of education, religion and wealth quintile), other factors included in our analysis were respondent's sex, age group, marital status, place of residence, smoking habit and if the respondent was suffering from any chronic disease. Sex differential in morbidity is well established in the literature (Gove and Hughes, 1979; Emsile, Hunt and Mackintyre, 1999). The prevalence of NCDs is very high at older ages. Several studies concluded that married persons were happier with lower stress, enjoyed greater social support, and were less engaged in risky health behaviours (Verbrugge, 1979; Robards et al., 2012). We have selected place of residence as a factor influencing health as urban people have higher living standards and greater access to health facilities (Zimmer et al., 2010; Lu et al., 2018). We have also incorporated the states of India as one of the background characteristics of the respondents as the socio-cultural settings influencing heath varies with region. In Our study West Bengal is located in the Eastern region, Assam in North-East, Karnataka in the South, Maharashtra in the West, Rajasthan in the North and Uttar Pradesh is situated in Central India. A person's health status also depends on smoking habits and chronic illness — the WHO repeatedly articulates the negative health impacts of tobacco smoking and chronic diseases. In our study, the information on chronic diseases was based on the available data from WHS-India, 2003. It included diagnosed cases of angina, arthritis, asthma, diabetes and depression. If a person mentioned that he/she was diagnosed with any of the above-listed diseases, we considered that the person was suffering from chronic illness.

Table 6.2: Percentage of people who reported poor health by demographic, health-related and regional characteristics in India, 2003

Background Characteristics		% reported poor health	N	Total	P-value
Sex	Male	12.8	653	4849	<.001
	Female	19.3	989	5145	
Age groups	15-29 years	7.6	271	3138	<.001
	30-44 years	12.6	477	3457	
	45-59 years	21.7	430	2052	
	60+	34.2	464	1347	
Marital status	Never married	5.6	88	1340	<.001
	Currently married/cohabiting	16.5	1258	7723	
	Separated/divorced /widowed	32.3	296	931	

Place of residence	Urban	13.6	365	2728	<.001
	Rural	16.9	1277	7266	
Currently smoke	No	14.8	1026	6673	<.001
	Yes	18.3	616	3321	
Suffering from any chronic disease	No	10.2	719	6507	<.001
	Yes	27.2	923	3487	
States	Assam	8.4	88	1046	<.001
	Karnataka	4.7	68	1431	
	Maharashtra	14.3	276	1972	
	Rajasthan	21.0	398	1816	
	Uttar Pradesh	18.4	382	2054	
	West Bengal	25.3	430	1675	

Source: Computed from the unit level analysis of WHS-India, 2003
Note: Percentages are calculated using sample weights
P-value is based on Pearson's Chi-square test

In table 6.2, a higher prevalence rate of poor health was observed among the females than the males. The percentage who reported poor health increased with age. The prevalence rate of poor health was almost two times higher among the separated/divorced/widowed than those currently married/cohabiting. A higher proportion of rural people reported poor health compared to urban people. The percentage of the population who reported poor health was higher among the smokers than the non-smokers. Poor health reporting was more than 2.5 times higher among those suffering from chronic diseases than their counterparts. Among the study states, the prevalence rate of poor health was as low as 4.7 per cent in Karnataka and as high as 25.3 per cent in West Bengal.

After covariate adjustment, the predicted probability of poor health in India is displayed in table 6.3. The results specify that socioeconomic inequality in health is a reality in India. The level of education, wealth, and religion significantly impact a person’s health status. As the level of education rises, the percentage of people reporting poor health decreases. For example, among those with no formal education/incomplete primary education, 19.7 per cent ($p<.001$) of them reported poor health, whereas among those who completed at least the higher secondary level of education, 11 per cent ($p<.001$) of them reported poor health. As we move from lower to higher wealth quintile, the proportion reporting poor health also decreases in each group. The percentage of the population who reported poor health was 19.1 per cent ($p<.01$) among the poorest quintile and 13.4 per cent ($p<.01$) among the wealthiest quintile. Controlling for the demographic, health-related and regional factors, the reporting of poor health was 15.1 per cent among the Hindus and 22.8 per cent (p<.001) among the non- Hindus.

Table 6.3: Predicted probability of poor health in India, 2003

Background characteristics		Predicted probability (%)
Sex	Male	14.2
	Female	18.7***
Age groups	15-29 years	11.0***
	30-44 years	15.0***
	45-59 years	20.9***
	60+	32.4***
Marital status	Never married	15.5
	Currently married/cohabiting	16.3
	Separated/divorced/widowed	19.1
Level of education	No education/ below primary	19.7***
	Primary completed	16.8*
	Secondary completed	14.7**
	Completed HS or higher	11.0***
Religion	Hindu	15.4
	Non-Hindu	21.6***
Wealth index	Poorest	19.1**
	Poorer	18.2
	Middle	16.1*
	Richer	15.9*
	Richest	13.4**
Currently smoke	No	16.6
	Yes	16.2
Suffering from chronic disease	No	12.8
	Yes	25.4***
Place of residence	Urban	16.4
	Rural	16.4
States	Assam	10.2***
	Karnataka	5.2***
	Maharashtra	14.0***
	Rajasthan	26.1
	Uttar Pradesh	23.0
	West Bengal	24.7***

Note: *p< 0.05, **p< 0.01, ***p< 0.001; N=9994
Source: Computed from unit level analysis of WHS-India, 2003

Our analysis also revealed that after covariate adjustment, higher reporting of poor health was observed among the females (18.7 per cent, p< 0.001) than the males (14.6 per cent). The proportion of the population reporting poor health significantly increased with age. We observed that 16.3 per cent of currently married/cohabiting people and 19.1 per cent of separated/divorced/widowed people reported poor health during the survey. But the result is statistically not significant. Interestingly, controlling for the background characteristics of the respondents, the prevalence of poor health did not vary between the rural and the urban population. Smoking habits also showed little impact on the health status of the people. In both cases, the results are not statistically significant. As evident from our analysis, the perceived health state was significantly influenced by the chronic diseases of the respondents. For those suffering from chronic illness, 25.4 per cent ($p<.001$) of them reported poor health. On the other hand, for those who were not suffering from any chronic disease, 12.8 per cent reported poor health. After covariate adjustment, significant inter-state variation in poor health reporting was observed among the states under study. The proportion of the population who reported poor health was 5.2 per cent ($p<.001$) in Karnataka, 10.2 per cent ($p<.001$) in Assam, 14.0 per cent ($p<.001$) in Maharashtra and 24.7 per cent ($p<.001$) in West Bengal. The results are not statistically significant for Rajasthan and Uttar Pradesh.

6.3.2. The healthy life expectancy of socioeconomic groups in India

Our analysis shows that socioeconomically disadvantaged groups reported a higher prevalence of poor health in India. As people with lower socioeconomic status (SES) experience lower life expectancies and a higher rate of morbidity, health expectancy represents larger inequality in health among socioeconomic groups (Mackenbach, 2002). In this context, we have estimated India's healthy life expectancy (HLE) by wealth and religion. For estimating HLE, we used the data of ASDR from NFHS-2 (1998-99) and age-specific prevalence rates of poor health from WHS-India, 2003. As the NFHS-2 did not provide information on the level of education of the deceased persons, we could not estimate HLE by the level of education. It is indeed a profound limitation of this study because education is a stable attribute in adult life, in contrast to income or wealth, which can vary with time (Szwarcwald et al., 2005).

Table 6.4 shows the healthy life expectancies of the poor and the non-poor groups. For categorising 'poor' and 'non-poor', we have used the variable 'standard of living index' of NFHS-2 and 'wealth quintile' of WHS-India, 2003. In NFHS-2, the standard of living index was categorised into 'low', 'medium' and 'high'. People with a low standard of living have been considered poor in determining mortality rates of the 'poor' and the 'non-poor'. Wealth quintile of WHS-2003 were categorized as 'poorest', 'poorer', 'middle', 'richer' and 'richest'. The first two groups were considered poor, and the rest were considered non-poor in the analysis of morbidity differences.

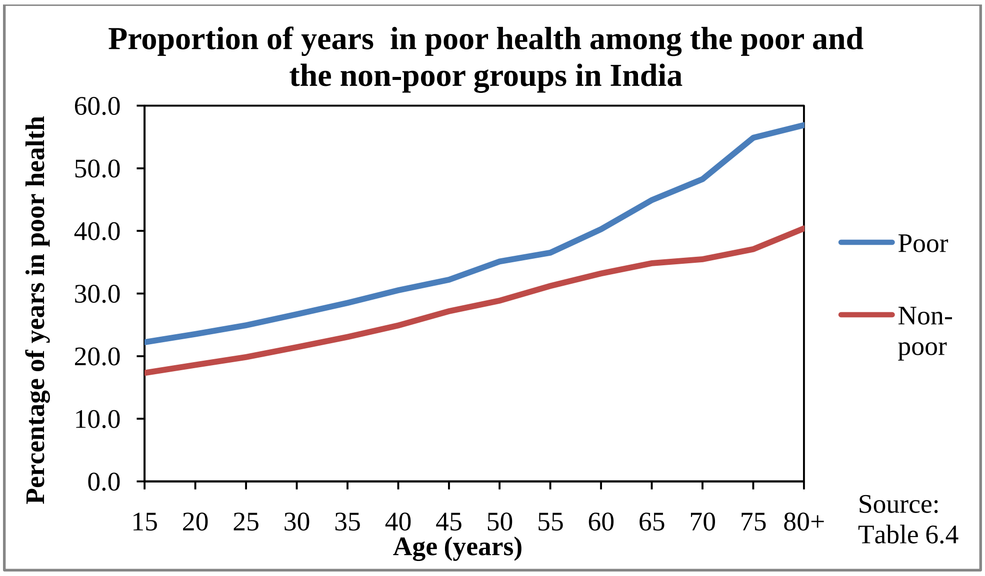
Table 6.4: Healthy life expectancies and the percentage of years in poor health of the poor and the non-poor groups in India by age

Age	Healthy life expectancies (Years)		Percentage of years in poor health	
	Poor	Non-poor	Poor	Non-poor
15	40.6	47.2	22.2	17.3
20	36.5	42.7	23.5	18.6
25	32.7	38.5	24.9	19.9
30	28.7	34.1	26.7	21.4
35	24.9	29.9	28.5	23.1
40	21.3	25.8	30.5	24.9
45	18.1	21.8	32.2	27.2
50	14.7	18.3	35.1	28.9
55	12.1	14.9	36.5	31.2
60	8.9	11.7	40.3	33.2
65	6.7	9.2	44.9	34.8
70	4.5	6.9	48.3	35.5
75	3.5	5.4	54.9	37.1
80+	2.0	3.2	56.9	40.4

Source: Computed using the unit level data of NFHS-2 (1998-99) and WHS-India, 2003

We observed that healthy life expectancy at any age (starting from 15 years) was higher among the non-poor than the poor (Table 6.4). The difference in healthy life expectancies between the poor and the non-poor was 6.6 years at 15 years. The difference tends to diminish with growing age. Fig. 6.1 shows the proportion of years in poor health to the total life expectancy of the two groups. The ratio was substantially higher among the

Fig 6.1: Proportion of years in poor health to total life expectancy of the poor and the non-poor groups in India



than the non-poor. The differences in the percentage of years lived in poor health between these two groups increased dramatically after age 60.

The required information to estimate HLE by religion is available from NFHS-2 and WHS-India, 2003. Based on that information, we have calculated the HLE of the Hindus and the non-Hindus (Table 6.5). The findings are pretty interesting. Healthy life expectancy was found higher among the Hindus aged 15-44 years, but from 50 years onwards, higher HLE was observed among the non-Hindus.

Table 6.5: Healthy life expectancies and the percentage of years in poor health of the Hindus and the non-Hindus in India by age

Age	Healthy life expectancies (Years)		Percentage of years in poor health	
	Hindu	Non-Hindu	Hindu	Non-Hindu
15	45.6	43.5	17.8	23.9
20	41.2	39.2	19.0	25.3
25	37.0	35.3	20.4	26.5
30	32.7	31.4	22.0	28.1
35	28.6	27.5	23.7	29.6
40	24.6	24.0	25.6	30.7
45	20.7	20.7	27.9	32.0
50	17.2	17.4	30.0	33.7
55	14.0	14.6	32.1	34.6
60	10.7	12.0	35.1	34.3
65	8.3	9.8	37.7	35.3
70+	5.8	8.1	40.2	31.5

Source: Computed using the unit level data of NFHS-2 (1998-99) and WHS-India, 2003

Fig 6.2: Proportion of years in poor health to total life expectancy of the Hindus and the non-Hindus in India

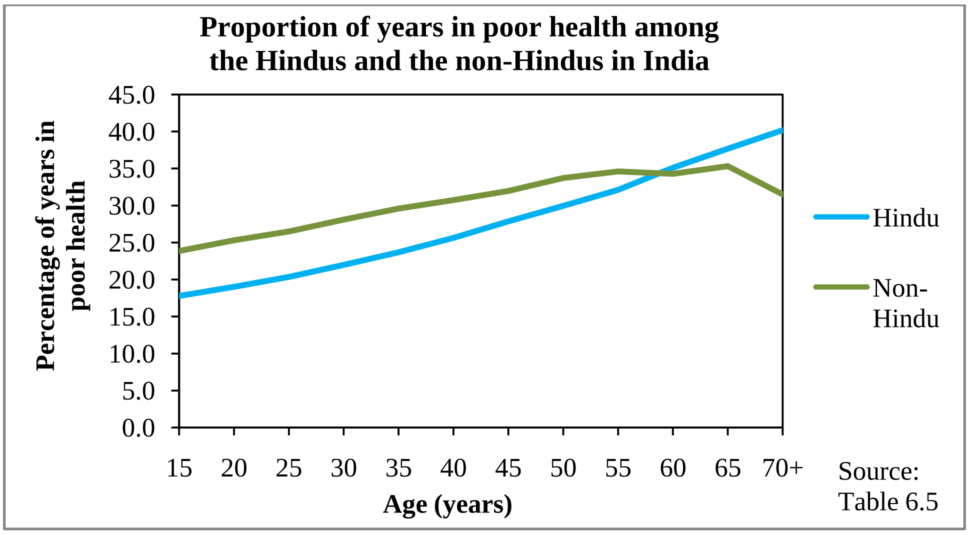


Fig. 6.2 shows the proportion of life in poor health to the total life expectancy of the Hindus and the non-Hindus in India. The graph depicts that the percentage of years in poor health of the Hindus was higher than the non-Hindus among the elderly population. The proportion of years in poor health of the non-Hindus drastically changed from 35.3 per cent at the age of 65 to 31.5 per cent at 70+.

Is it because the proportion of joint families was higher among the non-Hindus where better care was taken for the elderly? Analysing the data of NFHS-2, Saggurti and Nair (2005) found that non-Hindu households had a slightly higher percentage of nuclear families than Hindu households. So, the differential care of the elderly in the Hindu and non-Hindu families based on the type of family does not arise. Probably, the low sample size of the non-Hindus at the older ages could have an impact on our findings. Particularly, the sample size for calculating the mortality rates was extremely small for the elderly non-Hindu population.

6.4. Conclusion

From our study, it can be concluded that controlling for various demographic, socioeconomic and health-related factors, education, wealth, and religion were significant determinants of poor health. Our study finds that except for the elderly, the healthy life expectancy was higher among the Hindus than the non-Hindus. No suitable explanations are found from the existing literature to justify it. Probably, the meagre sample size of the non-Hindus at the older ages could influence our findings. However, the policymakers should consider the age groups while contemplating the health needs of the Hindus and the non-Hindus.

We observed that in India, both mortality and morbidity rates were higher among the poor, causing a considerable gap in HLE between the poor and the non-poor. The differences in the percentage of years lived in poor health between these two groups increased dramatically after 60, making the elderly poor extremely vulnerable. After covariate adjustment, it was found that the probability of reporting poor health was 1.8 times higher among those who did not have any formal education/incomplete primary education compared to those who completed at least a higher secondary level of education. However, due to the unavailability of data on the level of education of the deceased persons from NFHS-2, it is not possible to compute HLE by the level of education. Our results suggest that to improve the average health status of Indians, we need to focus on income generation and strengthen our education system because health, education and income are closely interlinked.

Chapter 7
Conclusion

7.1. Summary

Promoting physical and mental health and well-being was recognised as an integral component in the United Nations 2030 Agenda for Sustainable Development (United Nations, 2015) because good health is a prerequisite to well-being and the economic prosperity of any society. To know population's health status in a country, monitor the changes in their health state, and assess the socioeconomic inequality in health within a population, we need to select a suitable indicator for measuring health. The crude death rate, infant mortality rate, life expectancy at birth, etc., are some of the common indicators long been used to assess people's health status. Although the developed countries experienced a continuous decline in mortality rates and rise in life expectancies in the twentieth century, the increase in the length of life was mostly experienced as the years of disability (Crimmins, Saito and Ingegneri, 1989). Consequently, debates and discussions started on whether longer life means better health and are the mortality indicators enough to measure health? These considerations led to the formulation of Summary Measures of Population Health (SMPH) which combines morbidity and mortality data to show the health status of a population as a single numerical index. Some popular SMPH is Disability-Free Life Expectancy, Active Life Expectancy, Healthy Life expectancy, Disability-Adjusted Life Years, etc.

Globally the use of SMPH has substantially increased as it incorporates the impacts of non-fatal health outcomes in health planning and priority setting. Since India is experiencing population ageing and a higher incidence of chronic diseases are found at the later period of life, a greater need is felt for assessing the population health in India using SMPH. However, this field of study has not been adequately explored in India. Therefore, in the present study, we have measured the health status of the population of India and a few selected states by SMPH. As improved health conditions of the disadvantaged groups ultimately raise the average population health status, studies on socioeconomic inequalities in health are crucial (Mackenbach et al., 1997). In India, most of the available research in this field focuses on socioeconomic inequality by mortality, healthcare expenditure, maternal and child health care utilisation, infectious and chronic diseases, nutrition, and risk factors. However, research on socioeconomic inequality in healthy life expectancy (HLE) is scarce in India. To fill this gap, we have tried to assess the disparity in HLE in India by socioeconomic groups.

Since the works of Sanders (1964), numerous researchers have contributed to the development of various SMPH. Among them, recently, the use of Disability Adjusted Life Years (DALY), which combines Years Lost due to Disability (YLD) and Years of Life Lost due to Premature Mortality (YLL), has increased significantly. As YLD can be estimated following the incidence or prevalence approach, we assessed the data quality of the 60th and 75th rounds of the National Sample Survey (NSS) to adopt the suitable approach. We found that in both the rounds, inconsistency exists between the reported "status of ailment" and the "duration of ailment" and between the "life table estimates of the duration of ailment" and the "implied duration derived by mathematical relationship". The average duration of ailment is an essential input for the calculation of YLD, but we observed that the respondents have not correctly reported the total span of illnesses. Also, there is a chance of recall lapse in case of incidence. Therefore, we concluded that although the Global Burden of Disease Study (GBDS) preferred the incidence perspective to estimate YLD, the prevalence approach appeared more suitable in determining YLD using NSS data. Besides, it becomes apparent that data quality assessment is very important for adopting an appropriate approach to estimate YLD.

We found a gender difference in YLD for some diseases. In the case of joint and bone disorder, anaemia, filariasis, goitre and diseases of mouth/teeth/gum, YLD was more than 1.5 times higher among the females than males in 2004. In contrast, YLD was at least 1.5 times higher among the males than females in hepatitis/jaundice, worm infestation, tuberculosis, bronchial asthma, kidney/urinary system-related diseases, diphtheria, tetanus and speech disability. Our estimation shows that in India, YLL was higher for males (31403 per 100,000) than females (30349 per 100,000) in 2004.

As various challenges are found in DALY estimation for India (which are mentioned in the 'limitations of the study'), we have used another easy and popular SMPH called Disability-Free Life Expectancy (DFLE) to assess the health status of the population of India. We measured disability in terms of the prevalence of reported ailments (available from the 60th and 75th round of NSS); hence we used the term Ailment-Free Life Expectancy (AFLE). Our analysis revealed that both life expectancy and AFLE was higher among the females than the males. However, except for the age group 70-84 years, the proportion of years in poor health to total life expectancy was higher among the females. It indicates that except very old age group, gender paradox in health prevails in India when AFLE is considered.

We know health is not the mere absence of disease; it is “a state of complete physical, mental and social well-being” (WHO, 1946). Therefore, we have measured Healthy Life Expectancy (HLE) based on respondents’ perceptions about (1) overall health status, (2) activity limitation and (2) functional health, which involves social, psychological and physical domains of health. For this analysis, we used the data of the World Health Survey (WHS) conducted in India in 2003. We found that healthy life expectancies were lower among the females in all three cases than males. We also observed that HLE were higher in urban areas than in rural areas. However, except in infancy and early childhood, AFLE was higher among the rural population in 2004 and 2017-18. Our findings suggest that AFLE differs from HLE as the latter includes much broader aspects of health.

Our analysis of HLE led to another two crucial findings. First, the difference in HLE measured by three different aspects of health across all the age groups was minimal. Therefore, HLE based on self-rated general health may be used as a proxy to HLE measured by activity limitation or functional health (combining social, psychological and physical domain of health). Secondly, our categorisation of good health is different from OECD categorisation. When we dichotomised self-rated health (SRH) responses into ‘poor’ and ‘good’, we combined the responses – ‘very good’, ‘good’ and ‘moderate’ to get the category of good self-rated health. On the other hand, healthy life expectancies of the OECD countries are based on the percentage of the population who reported their health as good/excellent. Suppose we follow the OECD categorisation of good health. In that case, significant differences are observed in HLE in India, measured by three different aspects of health (self-rated general health, self-reported activity limitations and self-reported functional limitations). Therefore, we conclude that it is not wise to follow the OECD categorisation of ‘good health’ for India as SRH is essentially subjective, and the reporting of ‘poor’ or ‘good’ health is very much influenced by the cultural connotation of the health of a particular region (Jylha, 2009). In India, the general sense for the moderate health state seems to be normal health.

As India is a vast country with diverse socioeconomic settings, reporting of poor health and HLE is expected to vary from state to state. To understand the inter-state variation in healthy life expectancies in India, we have estimated HLE (based on self-rated general health) in six states in India (West Bengal, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, and Assam). Controlling for various demographic and socioeconomic factors, we observed that the proportion of the population who reported poor health was 5.2 per cent ($p<.001$) in Karnataka, 10.2 per cent ($p<.001$) in Assam, 14.0 per cent ($p<.001$) in Maharashtra and 24.7

per cent ($p<.001$) in West Bengal. The results were not significant for Rajasthan and Uttar Pradesh. The highest and the lowest life expectancies were observed in Maharashtra and Assam, respectively. However, Karnataka recorded the highest HLE, and West Bengal showed the lowest HLE. At age 20, the inter-state range in life expectancy was 6.2 years, but in the case of HLE, the range was 12.5 years. The difference in the range between LE and HLE demonstrates that the social determinants of health highly influence HLE. The inter-state variation in HLE diminishes with growing age.

As the rising burden of chronic diseases profoundly influences AFLE/HLE, we have assessed the recent changes in the burden of communicable and non-communicable diseases in India. Based on the analysis of the 60th (2004) and the 75th round (2017-18) of NSS data, we found that in 2004 in India, the prevalence rate of infectious/communicable diseases to total disease burden was higher than non-communicable diseases (NCDs). In 2017-18, the prevalence rate of NCDs surpassed the rate of infectious diseases. Particularly, there was a substantial increase in the burden of NCDs among the elderly between 2004 and 2017-18. For example, during this period, the prevalence of diabetes increased from 333.1 per 100,000 to 1000.6 per 100,000 populations. Nevertheless, infectious diseases still have a substantial share in the total disease burden in India. In 2004 and 2017-18, the proportion of both communicable and non-communicable diseases was higher among females than males. The ratio of infectious diseases to total disease burden was higher in rural areas, while urban areas recorded a higher proportion of NCDs in 2004 and 2017-18.

Besides gender and rural-urban differences, we have also studied socioeconomic inequalities in health outcomes. Our analysis found that the probability of reporting poor health gradually decreases with the increasing level of education and wealth quintile. The predicted probability of poor health was significantly higher among the non-Hindus (22.8 per cent) than the Hindus (15.1 per cent). We also observed that HLE was substantially higher among the poor than the non-poor. Except for the elderly, HLE was higher among the Hindus than the non-Hindus. Therefore, special attention should be provided to the health needs of the disadvantaged sections.

7.2. Limitations of the study

A few limitations of the present study can be pointed out. Among the SMPH, Disability-Adjusted Life Years (DALY) has gained immense popularity in measuring disease burden since its inception. However, according to Anand and Hanson (2006), DALY only represented the quantity of ill health while disease burden should incorporate economic and societal burden incurred by any disease/disability. They also questioned the arbitrary selection of standard life expectancy and the scientific basis for selecting disability weights used in DALY calculation.

Estimating DALY combines the YLL and the YLD. Although the Global Burden of Disease Study preferred the incidence approach for estimating YLD (Murray and Lopez, 1996), we found that the National Sample Survey (NSS) data is unsuitable for adopting the incidence approach. Also, the state-level sample size was too low to compute the YLD by state. Another problem that we faced during this study was the unavailability of the disease-specific disability weights for India. We have considered the disability weights of GBDS and computed the disability weights for several diseases/conditions based on existing literature in the context of India. Moreover, we have estimated the total YLL for India, but we were unable to calculate YLL by cause because of the scarcity of data. Hence, disease-specific DALY could not be computed. Here it should be mentioned that as the reports on Medical Certification of Cause of Death are based on records of selected hospitals and that too mostly from urban areas, this data may not present a reliable pattern of cause-specific mortality rates of India (Office of the Registrar General, India, 2021). Hence, they are not used for our study.

In the present study, the prevalence rate of any disease/condition is based on self-reporting and therefore, there is a possibility of non-disclosure. The self-reported information may vary from the clinically tested and laboratory-confirmed results of any disease. In the 75th round of NSS (2017-18), the working definition for the diagnosis of ailments was provided to the field investigators. Still, the accuracy of data may vary with the efficiency of the investigators and the level of understanding of the respondents. No such instructions were provided to the field staff in the 60th round of NSS (2004).

We have grouped the ailments/reported diagnosis into communicable and non-communicable diseases and analysed the changes in the prevalence of infectious and non-communicable diseases between 2004 and 2017-18. However, the list of ailments provided in the 60th and 75th rounds of NSS was not the same. Therefore, in a strict sense, they are not comparable.

We have used the information on Self-Rated Health (SRH) from the World Health Survey (WHS)-India, 2003 to calculate Healthy Life Expectancy (HLE). Several studies pointed to the lacunae in using SRH in determining the socioeconomic inequalities in health (Sauerborn et al., 1996; Subramanian et al., 2009; Jain et al., 2012). For example, there is a tendency of under-reporting ill-health among the poor. Poor people ignore the disease because they cannot afford to lose their earnings. Also, they use fewer health services than the non-poor; as a result, they fail to realise the presence of illness. Sen (2006) opined that among Indian states, Kerala had a much higher reported morbidity rate than Bihar because Kerala had a higher older population, and the reporting of morbidity in Kerala was more owing to its very high literacy rate and extensive public health facilities. However, Cullati et al. (2018) already assessed the construct validity of the SRH item of WHS-India, 2003 and concluded that the self-rated general health was a reliable indicator for determining the health status of the population of India. We also have to remember that although SRH is subjective and contextual, it is often not feasible for a researcher, particularly in developing countries, to get the information of medically diagnosed illness or disability (Suchman, Phillips and Streib, 1958).

The mechanism through which socioeconomic inequality affects the health perception of people is beyond our scope of analysis. One potential limitation of our study is that the cross-sectional nature of data does not allow causal inferences. It is not possible to conclude whether poor health led to inequality in education/wealth or inequality in education/wealth led to poor health.

Finally, no population-based survey in India provided data on both self-rated general health and adult mortality rates. Hence, we assessed the inequality in healthy life expectancy by socioeconomic groups using the information on SRH from WHS-India, 2003 and mortality data from NFHS-2 (1998-99). Between 1998 and 2003, the death rate in India declined only from 9.0 to 8.0 per 1000 (Registrar General in India, 2014); therefore, we assumed that there would not be significant differences in self-rated health among the Indians between 1998 and 2003. Further, NFHS-2 did not provide information about the level of education of the dead persons and information about caste is not available from WHS-India, 2003. Therefore, healthy life expectancy by education and caste cannot be computed.

7.3. Recommendations

In India, declining fertility rates, reduction in mortality, and increasing survival at older ages are causing population ageing. The share of the elderly is projected to reach 19 per cent in 2050 (United Nations Population Fund, 2017). Therefore, the prevalence of morbidity at older ages will increase in society. The burden of non-communicable diseases has already exceeded the burden of infectious diseases in India. Also, different regions of India are at various stages of demographic transition. Population ageing is occurring at a faster pace in the southern states of India compared to the north-central states. In this situation, mortality indicators are not enough to express the health status of the population of India. Therefore, we should emphasise the use of summary measures of population health, because, in public health policymaking, the burden of NCDs should be duly recognised. As the developed countries witnessed population ageing and the rise in the burden of chronic diseases long before the developing countries, the use of SMPH has become widespread in developed countries. The European Commission regularly publishes data on healthy life years of the countries of the European Union. The report "Health at a Glance" published by the OECD each year provides information on life expectancy at birth and HLE for the elderly population (at the age 65). The present situation in India also demands more research on assessing people's health status using SMPH. The government should take initiatives to publish data on the health status of the population of India using the indicators of SMPH.

Healthy life expectancy is a popular summary measure of population health. We observed that in India, HLE derived from self-rated general health could be a substitute to HLE based on activity limitations/functional health (particularly among the elderly) because when people assess their health, they perceive health in totality. In this context, we strongly recommend including the question on self-rated general health in National Family Health Survey (NFHS). The existing literature reveals that the question on SRH was included in the Demographic Health Survey, 2011 in Colombia (Pinilla-Roncancio, Gonzalez-Uribe and Lucni, 2020). As the age-specific mortality rates can be obtained from the NFHS, we would be able to estimate healthy life expectancy by socioeconomic groups from the dataset. We know that SRS does not provide mortality rates by socioeconomic groups; therefore, it is challenging to measure the socioeconomic inequality in HLE in India. The inclusion of just one question in the NFHS questionnaire will also expand the research opportunity regarding SMPH.

However, it is important to mention that despite the simplicity, reliability and validity, many researchers are sceptical about using SRH, particularly in low and middle-income countries. We also find that in Assam, where the level of development and life expectancy is low, HLE was almost similar to Maharashtra. Therefore, the problem arises in comparability among the states regarding HLE. Recently one study from India suggested that the "use of vignettes during data collection and decomposition analysis at the analysis stage can be used for making valid comparisons among population subgroups" (Prinja, Jeet and Kumar, 2012, p. 9 of 15). Using vignettes in the large-scale population-based surveys would facilitate a better interpretation of the inter-state variation in HLE. Like the Domestic Violence Module, a separate section on health state valuation can be added to the questionnaire of NFHS.

Based on our research experience and findings, we have outlined more recommendations and suggestions below.

While examining the NSS data (Round 60 and Round 75) on morbidity, we found some discrepancies in the data, such as inconsistency between reported "status of ailment" and "duration of ailment". These problems can be managed by proper training of the field investigators so that during the survey, they can identify the discrepancy and correct it immediately by crosschecking the respondent's answer on the status and duration of ailments. Also, the information on the duration of the disease/condition should be carefully recorded. These are not complicated things and can easily be done with extra care during data collection. The shortcoming of NSS data on morbidity must be paid apt attention to as the quality of data influences the research findings, which determines the policy decisions.

In the computation of YLD, we faced a considerable challenge regarding disease-specific disability weight. The India State-level Disease Burden Initiative Collaborators published an article in 2017 in the "Lancet" on the inter-state variations in epidemiological transition in India. Its methodology section cited the reference regarding disability weights used in their research. However, we have gone through the referred article and cannot find the cause-specific disability weights. We strongly believe that the data on disability weights used in the Indian context should be published. Besides, the Million Death Study data based on verbal autopsy to identify the causes of death in India is population-based survey data. This data also needs to be released. The availability of information on disability weights and mortality rates by age and cause in the public domain will allow more research using SMPH.

Our analysis shows that between 2004 and 2017-18, the proportion of NCDs not only increased among the elderly but also significantly increased in the age group 45-59 years which is a matter of grave concern. Through various policy interventions and programmes, like the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (launched in 2010) and the National Programme for Health Care of Elderly (launched in 2010–11), the Government of India is trying to prevent and control the non-communicable diseases (Arokiasamy, 2018). Using mainstream media and social media, the government should start awareness campaigns on the debilitating effects of NCDs on overall health and family expenditure and how we can combat it. Emphasis should be given on pursuing healthy lifestyles through practising yoga and physical exercise, including walking, quitting smoking and substance use, increasing the intake of fruits, vegetables and dietary fibres, lowering the intake of salt (under a teaspoon per day for adults recommended by WHO) and sugar (5-10 teaspoons of free sugar per day recommended by WHO), consuming lesser processed food and maintaining sleep hygiene. However, we should not focus only on NCDs because, in India, the share of infectious diseases to total disease burden in 2017-18 was substantial (45 per cent) and particularly high among the children and the oldest old age group. As India carries the dual burden of both infectious diseases and NCDs, the government must adopt a comprehensive policy framework emphasising both infectious diseases and NCDs. More focussed policies and programmes are needed to prevent and control contagious diseases among children and NCDs among the middle-aged and elderly.

A considerable variation in the prevalence rates of some diseases was observed by gender and residence, and the public health policymakers should consider these factors during policy formulation. For example, we found that disorders of joints and bones, anaemia, goitre etc., had considerably higher prevalence rates among the women, and the prevalence rates of hepatitis/jaundice, tuberculosis, bronchial asthma etc., were much higher among the men. In such cases, policymakers should pay greater attention to the more affected gender during disease-specific policy formulation. To reduce the prevalence rate of communicable diseases, particularly in rural areas, India can learn from pre-reformed China, which emphasised preventive health campaigns, building medical infrastructure and an extensive network of health workers, and developing collective health insurance arrangements (Sen, 2002). Under the Swachh Bharat Mission (SBM) launched by the honourable Prime Minister Sri Narendra Modi in 2014, India, too, has achieved enormous success in universalising sanitation coverage. A recent scientific report revealed that since 2014 the sanitation coverage in India has increased at the rate of 22.5 per cent (Mukherjee et al., 2019). Better sanitation means a lower rate of open defecation, hence a lower prevalence of acute diarrhoea. According to WHO, SBM-Grameen was likely to prevent more than 300,000 deaths and 14 million DALYs caused by diarrhoea and protein-energy malnutrition between 2014 and October 2019 (The Hindu, 2018). Government should take similar preventive initiatives to eradicate other communicable diseases like malaria, hepatitis, sexually transmitted infections etc. The government must immediately enact strong laws to curb pollution because increased SPM (Suspended Particulate Matter) in the air can cause respiratory and cardiovascular diseases and reproductive and central nervous system dysfunctions (Manisalidis et al., 2020). Pollution control is also necessary to curb global warming and associated disasters responsible for inexpressible human suffering, loss of life, livelihood, and biodiversity. In India, Pradhan Mantri Ujjwala Yojana (PMUY) was initiated in 2016 to increase clean energy usage, help low-income families, particularly women, and reduce health disorders, air pollution, and deforestation. Recent studies show that the project is not at par with its initial success, which is evident from the increasing trend of inactive LPG connections (Ranjan and Singh, 2020). The central government should review the situation and take suitable actions for the programme's success. For the BPL families, the government may provide considerably subsidised LPG cylinders. The central government also should ensure that under the Pradhan Mantri Jan Arohya Yojana, the largest health assurance scheme in the world, the poor and vulnerable families must get monetary assistance at the time of need.

We found that when health was measured in terms of ailment, women had higher AFLE. However, when health was expressed in terms of physical, mental and social well-being, women experienced lower healthy life expectancy. Possibly interpersonal relations, tension and anxiety, etc., affect women's health and well-being more than men. Therefore, researchers should carefully choose the appropriate SMPH for their study. Particularly those working on women's health must explore the physical, social and mental aspects of the health of their study population.

It was observed that the proportion of years in poor health to total life expectancy was higher among women in the case of both AFLE (except age group 70 to 84) and HLE. This finding is significant because "the length of both healthy life expectancy and total life expectancy could increase, but the proportion of healthy life expectancy could decrease. Making length of healthy life expectancy alone the target of health policy may not achieve the intended goal" (Saito, Robin and Crimmins, 2014, 16 of 24). We also suggest that even if life expectancy and AFLE are higher among women, they need special attention in health policy as their proportion of life in poor health is higher than men.

In our study, we have reiterated that the average health status of any population will be negatively affected if the health status of any of its sub-groups is comparatively low. As healthy life expectancy was higher among the non-poor than the poor, the government should support income-generating activities among the poor to reduce poverty and improve their standard of living. It will help to enhance their health status. Also, the level of education is negatively correlated with health. Therefore, it is crucial to ensure people's right to education by expanding education facilities and providing quality education. The government must increase its budgetary allocation in education. The government of India spent only 3.1 per cent of its GDP on education in 2019-'20 against the 6 per cent recommended by every national education policy since 1968 (Khaitan, 2021). We found compared to the Hindus higher proportion of non-Hindus reported poor health. According to the Census of India 2011, among 20.2 per cent non-Hindus in India, the majority are Muslims (14.2 per cent). Among various reasons, a high level of poverty and a low level of education among Muslims may explain the observed differences. Therefore, the government should take appropriate measures to improve the standard of living of Muslims so that they can attain better health.

Finally, substantial inter-state variation was observed in India in reporting of poor health and healthy life expectancy. It is interesting to look into why there was a large and significant difference among the states under study in reporting poor health and healthy life expectancies.

In 2004, the highest reported morbidity prevalence rate was observed in West Bengal (8.5 per cent). The WHS-India (2003) revealed that the maximum percentage of people reporting poor health was also from West Bengal. Besides, after covariate adjustment, we found that reporting of poor health was significantly higher (in fact, double) among the patients suffering from chronic diseases than their counterparts. Therefore, the prevalence of morbidity has a direct co-relation with SRH. In 2004 in India, among reported ailments, the highest prevalence rate was estimated for disorders of joints and bones followed by hypertension, respiratory illness and diabetes. According to WHS 2003, the proportion of people who received treatment for diabetes and arthritis was the highest in Karnataka (96.1 per cent and 72.8 per cent, respectively), and the percentage of the population treated for angina and asthma was also higher in Karnataka compared to the most of the states. It indicates that the opportunity of availing the treatment for diseases probably has an association with self-rated health.

If we look at the health care expenditure by the government, we find that per capita public health care expenditure varies across the states. We found that among the six states, the highest per capita public health care expenditure in 2004-05 was made by Karnataka, Rs. 233, but in West Bengal, it was only Rs. 173 (National Health Accounts Cell, Government of India, 2009). The maximum share of public health expenditure to total health expenditure in 2004-05 was also found in Karnataka (28.08 per cent). It was the lowest in Uttar Pradesh (13.12 per cent), and in West Bengal, it was 13.72 per cent. Data shows that Karnataka had the highest number of allopathic doctors, general nurses, midwives and auxiliary nurse midwives per 100,000 populations in 2002 (Arokiasamy et al., 2006). In contrast, in West Bengal, the number of doctors was almost half, and the number of general nurses and midwives was nearly a third of Karnataka. In 2008 in West Bengal, the shortfalls of paediatricians, obstetricians and gynaecologists, and total specialists at community health centres were 92.8 per cent, 89.1 per cent and 86.7 per cent, respectively (Shabnam, 2012). The above facts indicate that public health expenditure and health care infrastructure are directly associated with the health status of the people.

In 2004 the percentage of households that made out of pocket expenditure on health was the lowest in Karnataka (30.7 per cent) and the highest in Uttar Pradesh (46.1 per cent), followed by West Bengal (44.9 per cent) (Pandey et al., 2018). Therefore, the inter-state variation of self-rated morbidity depends not only on the cultural connotation of health but also on the availability and affordability of health care services, which in turn depends on the state governments' health policies. As public health is a subject matter of the states in India, state governments should strengthen the public health care system, particularly in rural areas, so that people can avail themselves of good treatment at a lower cost. It will undoubtedly have a positive influence on the perceived health state of the population.

In conclusion, we can say that as India is experiencing population ageing and an increasing burden of non-communicable diseases, we should use SMPH as an indicator of population health. The data constrain is a significant factor behind the limited use of SMPH in India. Individual researchers will benefit a lot if the data on disability weights used by India State-level Disease Burden Initiative Collaborators and the information on age-specific mortality rates by cause used in Million Death Study is made available in the public domain. Adding the question on self-rated health in NFHS would expand vast research opportunities in this field and make it possible to assess the inequality in healthy life expectancy among the socioeconomic groups in India. We found that substantial differences exist in healthy life expectancies among socioeconomic groups. Instead of blaming the marginalised groups, we need to find out the causes of observed differences. The government should adopt the policies and programmes that will minimise the differences in health status among socioeconomic groups, between men and women and between rural and urban areas, and improve the average health status of the population of India. The share of GDP spent on public health by the government of India is among one of the lowest in the world. The government should raise it to at least 2.5 per cent of the GDP to meet the health-related targets of Sustainable Development Goals 2030. Along with the central government, the state governments must spend more on public health to make health services available, accessible, and affordable for all. Besides government initiatives, individuals should follow a healthy lifestyle to prevent and control diseases, particularly non-communicable diseases.

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Appendix

Appendix 2.1: Cases of Incidence, point prevalence and period prevalence of hypertension, 2004

Duration (in days)*	**Status of illness				Period prevalence	Incidence	Point prevalence
	1	2	3	4	1+2+3+4	3+4	1+3
1	1	1	4	3	9	7	5
2	3	1	3	13	20	16	6
3	2	2	8	15	27	23	10
4	2	5	4	7	18	11	6
5	5	3	11	9	28	20	16
6	5	3	3	6	17	9	8
7	2	0	7	5	14	12	9
8	2	0	3	2	7	5	5
9	0	0	1	0	1	1	1
10	10	3	10	5	28	15	20
11	1	0	0	0	1	0	1
12	1	0	9	1	11	10	10
13	1	0	0	0	1	0	1
14	3	0	3	0	6	3	6
15	180	1	24	1	206	25	204
16-30	74	7	5	0	86	5	79
31-60	49	1	3	1	54	4	52
61-180	168	2	6	3	179	9	174
>180	1545	3	17	8	1573	25	1562
Total	2054	32	121	79	2286	200	2175

Source: Computed from unit level data of NSS, Round 60, 2004

Note: Persons with age over 100 years has not been considered (<0.1 percent of persons were reported to be over 100 years)

*Persons with missing duration are not included (<1 percent of sample)

**Status 1= Started more than 15 days ago and is continuing

Status 2= Started more than 15 days ago and has ended

Status 3= Started within 15 days and is continuing

Status 4= Started within 15 and has ended

Appendix 2.2: Computation of average duration of ailment from heart disease using life table method based on NSS data, Round 60, 2004

Duration (days)	Mid point	Width	Total observation	(Contd.) Censored 1+3	(ended) Complete 2+4	Number entering interval	Number exposed to risk	Conditional proportion ending	Conditional proportion continuing	Cumulative proportion continuing	
t	m	w	O	E	F	G	G - E/2 = H	F/H	1- F/H = P	Ci+1 = Ci*P	C*w
0	0.5	1	0	0	0	1670125	1670125.0	0.00000	1.00000	1.00000	1.00000
1	1.5	1	4855	4021	834	1670125	1668114.5	0.00050	0.99950	1.00000	1.00000
2	2.5	1	27747	10910	16837	1665270	1659815.0	0.01014	0.98986	0.99950	0.99950
3	3.5	1	18504	16490	2014	1637523	1629278.0	0.00124	0.99876	0.98936	0.98936
4	4.5	1	19409	7557	11852	1619019	1615240.5	0.00734	0.99266	0.98814	0.98814
5	5.5	1	22759	7244	15515	1599610	1595988.0	0.00972	0.99028	0.98089	0.98089
6	6.5	1	14913	3787	11126	1576851	1574957.5	0.00706	0.99294	0.97135	0.97135
7	7.5	1	25286	6691	18595	1561938	1558592.5	0.01193	0.98807	0.96449	0.96449
8	8.5	1	11047	4642	6405	1536652	1534331.0	0.00417	0.99583	0.95298	0.95298
9	9.5	1	1801	193	1608	1525605	1525508.5	0.00105	0.99895	0.94901	0.94901
10	10.5	1	40009	25151	14858	1523804	1511228.5	0.00983	0.99017	0.94800	0.94800
11	11.5	1	2161	2161	0	1483795	1482714.5	0.00000	1.00000	0.93868	0.93868
12	12.5	1	2332	2332	0	1481634	1480468.0	0.00000	1.00000	0.93868	0.93868
13	13.5	1	14003	10880	3123	1479302	1473862.0	0.00212	0.99788	0.93868	0.93868
14	14.5	1	12672	11683	989	1465299	1459457.5	0.00068	0.99932	0.93670	0.93670
15	15.5	1	276566	271477	5089	1452627	1316888.5	0.00386	0.99614	0.93606	0.93606
16	16.5	1	8818	8818	0	1176061	1171652.0	0.00000	1.00000	0.93244	0.93244
17	17.5	1	1168	1168	0	1167243	1166659.0	0.00000	1.00000	0.93244	0.93244
18	19.0	2	6918	6918	0	1166075	1162616.0	0.00000	1.00000	0.93244	1.86489
20	20.5	1	9091	6838	2253	1159157	1155738.0	0.00195	0.99805	0.93244	0.93244
21	21.5	1	3220	3220	0	1150066	1148456.0	0.00000	1.00000	0.93063	0.93063
22	22.5	1	1339	1339	0	1146846	1146176.5	0.00000	1.00000	0.93063	0.93063
23	24.0	2	7792	7792	0	1145507	1141611.0	0.00000	1.00000	0.93063	1.86125
25	26.5	3	4597	3925	672	1137715	1135752.5	0.00059	0.99941	0.93063	2.79188
28	29.0	2	689	689	0	1133118	1132773.5	0.00000	1.00000	0.93007	1.86015
30	30.5	1	36915	36915	0	1132429	1113971.5	0.00000	1.00000	0.93007	0.93007

31	31.5	1	1172	1172	0	1095514	1094928.0	0.00000	1.00000	0.93007	0.93007
32	32.5	1	3199	3199	0	1094342	1092742.5	0.00000	1.00000	0.93007	0.93007
33	33.5	1	445	445	0	1091143	1090920.5	0.00000	1.00000	0.93007	0.93007
34	34.5	1	300	300	0	1090698	1090548.0	0.00000	1.00000	0.93007	0.93007
35	35.5	1	6750	6750	0	1090398	1087023.0	0.00000	1.00000	0.93007	0.93007
36	37.0	2	423	423	0	1083648	1083436.5	0.00000	1.00000	0.93007	1.86015
38	39.0	2	1834	1834	0	1083225	1082308.0	0.00000	1.00000	0.93007	1.86015
40	41.0	2	6327	6327	0	1081391	1078227.5	0.00000	1.00000	0.93007	1.86015
42	43.5	3	456	456	0	1075064	1074836.0	0.00000	1.00000	0.93007	2.79022
45	46.0	2	29649	29649	0	1074608	1059783.5	0.00000	1.00000	0.93007	1.86015
47	47.5	1	3397	3397	0	1044959	1043260.5	0.00000	1.00000	0.93007	0.93007
48	49.0	2	634	634	0	1041562	1041245.0	0.00000	1.00000	0.93007	1.86015
50	50.5	1	7811	7440	371	1040928	1037208.0	0.00036	0.99964	0.93007	0.93007
51	51.5	1	434	434	0	1033117	1032900.0	0.00000	1.00000	0.92974	0.92974
52	53.0	2	824	824	0	1032683	1032271.0	0.00000	1.00000	0.92974	1.85948
54	54.5	1	514	514	0	1031859	1031602.0	0.00000	1.00000	0.92974	0.92974
55	56.5	3	87	87	0	1031345	1031301.5	0.00000	1.00000	0.92974	2.78923
58	58.5	1	775	775	0	1031258	1030870.5	0.00000	1.00000	0.92974	0.92974
59	59.5	1	356	356	0	1030483	1030305.0	0.00000	1.00000	0.92974	0.92974
60	61.0	2	26568	26083	485	1030127	1017085.5	0.00048	0.99952	0.92974	1.85948
62	63.0	2	839	533	306	1003559	1003292.5	0.00030	0.99970	0.92930	1.85860
64	64.5	1	251	251	0	1002720	1002594.5	0.00000	1.00000	0.92902	0.92902
65	66.5	3	3091	3091	0	1002469	1000923.5	0.00000	1.00000	0.92902	2.78705
68	69.0	2	1020	1020	0	999378	998868.0	0.00000	1.00000	0.92902	1.85803
70	70.5	1	7848	7848	0	998358	994434.0	0.00000	1.00000	0.92902	0.92902
71	72.0	2	1485	1485	0	990510	989767.5	0.00000	1.00000	0.92902	1.85803
73	74.0	2	389	389	0	989025	988830.5	0.00000	1.00000	0.92902	1.85803
75	75.5	1	2502	2502	0	988636	987385.0	0.00000	1.00000	0.92902	0.92902
76	76.5	1	899	899	0	986134	985684.5	0.00000	1.00000	0.92902	0.92902
77	78.0	2	809	809	0	985235	984830.5	0.00000	1.00000	0.92902	1.85803
79	79.5	1	268	268	0	984426	984292.0	0.00000	1.00000	0.92902	0.92902
80	82.5	5	4028	4028	0	984158	982144.0	0.00000	1.00000	0.92902	4.64508
85	87.5	5	591	591	0	980130	979834.5	0.00000	1.00000	0.92902	4.64508
90	92.0	4	41258	40706	552	979539	959186.0	0.00058	0.99942	0.92902	3.71606
94	94.5	1	3004	3004	0	938281	936779.0	0.00000	1.00000	0.92848	0.92848
95	95.5	1	13858	13858	0	935277	928348.0	0.00000	1.00000	0.92848	0.92848
96	97.0	2	658	658	0	921419	921090.0	0.00000	1.00000	0.92848	1.85696

98	98.5	1	493	493	0	920761	920514.5	0.00000	1.00000	0.92848	0.92848
99	99.5	1	9397	9397	0	920268	915569.5	0.00000	1.00000	0.92848	0.92848
100	100.5	1	8940	8940	0	910871	906401.0	0.00000	1.00000	0.92848	0.92848
101	103.0	4	2042	2042	0	901931	900910.0	0.00000	1.00000	0.92848	3.71392
105	106.5	3	5734	5734	0	899889	897022.0	0.00000	1.00000	0.92848	2.78544
108	108.5	1	312	312	0	894155	893999.0	0.00000	1.00000	0.92848	0.92848
109	109.5	1	20040	20040	0	893843	883823.0	0.00000	1.00000	0.92848	0.92848
110	111.5	3	675	675	0	873803	873465.5	0.00000	1.00000	0.92848	2.78544
113	114.0	2	382	382	0	873128	872937.0	0.00000	1.00000	0.92848	1.85696
115	117.5	5	4712	4712	0	872746	870390.0	0.00000	1.00000	0.92848	4.64240
120	121.0	2	27617	27617	0	868034	854225.5	0.00000	1.00000	0.92848	1.85696
122	123.5	3	1091	1091	0	840417	839871.5	0.00000	1.00000	0.92848	2.78544
125	125.5	1	3274	3274	0	839326	837689.0	0.00000	1.00000	0.92848	0.92848
126	127.0	2	153	153	0	836052	835975.5	0.00000	1.00000	0.92848	1.85696
128	128.5	1	782	782	0	835899	835508.0	0.00000	1.00000	0.92848	0.92848
129	129.5	1	1482	1482	0	835117	834376.0	0.00000	1.00000	0.92848	0.92848
130	130.5	1	1996	1996	0	833635	832637.0	0.00000	1.00000	0.92848	0.92848
131	132.5	3	642	642	0	831639	831318.0	0.00000	1.00000	0.92848	2.78544
134	134.5	1	334	334	0	830997	830830.0	0.00000	1.00000	0.92848	0.92848
135	135.5	1	101	101	0	830663	830612.5	0.00000	1.00000	0.92848	0.92848
136	137.5	3	1986	1986	0	830562	829569.0	0.00000	1.00000	0.92848	2.78544
139	139.5	1	888	888	0	828576	828132.0	0.00000	1.00000	0.92848	0.92848
140	141.0	2	5061	5061	0	827688	825157.5	0.00000	1.00000	0.92848	1.85696
142	143.5	3	394	394	0	822627	822430.0	0.00000	1.00000	0.92848	2.78544
145	145.5	1	244	244	0	822233	822111.0	0.00000	1.00000	0.92848	0.92848
146	147.0	2	11139	11139	0	821989	816419.5	0.00000	1.00000	0.92848	1.85696
148	148.5	1	2947	2947	0	810850	809376.5	0.00000	1.00000	0.92848	0.92848
149	149.5	1	1405	1405	0	807903	807200.5	0.00000	1.00000	0.92848	0.92848
150	150.5	1	25927	25927	0	806498	793534.5	0.00000	1.00000	0.92848	0.92848
151	152.0	2	160	160	0	780571	780491.0	0.00000	1.00000	0.92848	1.85696
153	154.0	2	569	569	0	780411	780126.5	0.00000	1.00000	0.92848	1.85696
155	155.5	1	3368	3368	0	779842	778158.0	0.00000	1.00000	0.92848	0.92848
156	158.0	4	109	109	0	776474	776419.5	0.00000	1.00000	0.92848	3.71392
160	162.5	5	3435	3435	0	776365	774647.5	0.00000	1.00000	0.92848	4.64240
165	166.5	3	1991	1991	0	772930	771934.5	0.00000	1.00000	0.92848	2.78544
168	169.0	2	4801	4801	0	770939	768538.5	0.00000	1.00000	0.92848	1.85696
170	171.5	3	2303	2303	0	766138	764986.5	0.00000	1.00000	0.92848	2.78544

173	174.0	2	530	530	0	763835	763570.0	0.00000	1.00000	0.92848	1.85696
175	175.5	1	1681	1681	0	763305	762464.5	0.00000	1.00000	0.92848	0.92848
176	177.0	2	376	376	0	761624	761436.0	0.00000	1.00000	0.92848	1.85696
178	179.0	2	1317	1317	0	761248	760589.5	0.00000	1.00000	0.92848	1.85696
180	181.0	2	36342	36342	0	759931	741760.0	0.00000	1.00000	0.92848	1.85696
182	182.5	1	25379	25379	0	723589	710899.5	0.00000	1.00000	0.92848	0.92848
183	184.0	2	474	474	0	698210	697973.0	0.00000	1.00000	0.92848	1.85696
185	185.5	1	2696	2696	0	697736	696388.0	0.00000	1.00000	0.92848	0.92848
186	187.0	2	167	167	0	695040	694956.5	0.00000	1.00000	0.92848	1.85696
188	189.0	2	668	668	0	694873	694539.0	0.00000	1.00000	0.92848	1.85696
190	191.0	2	2524	2524	0	694205	692943.0	0.00000	1.00000	0.92848	1.85696
192	196.0	8	3888	3888	0	691681	689737.0	0.00000	1.00000	0.92848	7.42785
200	201.5	3	5921	5921	0	687793	684832.5	0.00000	1.00000	0.92848	2.78544
203	204.0	2	1711	1711	0	681872	681016.5	0.00000	1.00000	0.92848	1.85696
205	206.0	2	1930	1930	0	680161	679196.0	0.00000	1.00000	0.92848	1.85696
207	207.5	1	3097	3097	0	678231	676682.5	0.00000	1.00000	0.92848	0.92848
208	209.0	2	503	503	0	675134	674882.5	0.00000	1.00000	0.92848	1.85696
210	211.0	2	6756	6756	0	674631	671253.0	0.00000	1.00000	0.92848	1.85696
212	213.0	2	3345	3345	0	667875	666202.5	0.00000	1.00000	0.92848	1.85696
214	214.5	1	173	173	0	664530	664443.5	0.00000	1.00000	0.92848	0.92848
215	215.5	1	13036	13036	0	664357	657839.0	0.00000	1.00000	0.92848	0.92848
216	216.5	1	461	461	0	651321	651090.5	0.00000	1.00000	0.92848	0.92848
217	217.5	1	2225	2225	0	650860	649747.5	0.00000	1.00000	0.92848	0.92848
218	218.5	1	296	296	0	648635	648487.0	0.00000	1.00000	0.92848	0.92848
219	219.5	1	11286	11286	0	648339	642696.0	0.00000	1.00000	0.92848	0.92848
220	225.0	10	963	963	0	637053	636571.5	0.00000	1.00000	0.92848	9.28481
230	232.5	5	637	637	0	636090	635771.5	0.00000	1.00000	0.92848	4.64240
235	237.5	5	2791	2791	0	635453	634057.5	0.00000	1.00000	0.92848	4.64240
240	241.0	2	15446	15446	0	632662	624939.0	0.00000	1.00000	0.92848	1.85696
242	242.5	1	225	225	0	617216	617103.5	0.00000	1.00000	0.92848	0.92848
243	244.0	2	462	462	0	616991	616760.0	0.00000	1.00000	0.92848	1.85696
245	245.5	1	1916	1916	0	616529	615571.0	0.00000	1.00000	0.92848	0.92848
246	248.0	4	370	370	0	614613	614428.0	0.00000	1.00000	0.92848	3.71392
250	252.5	5	9342	9342	0	614243	609572.0	0.00000	1.00000	0.92848	4.64240
255	256.5	3	2982	2982	0	604901	603410.0	0.00000	1.00000	0.92848	2.78544
258	259.0	2	1127	1127	0	601919	601355.5	0.00000	1.00000	0.92848	1.85696
260	261.0	2	1016	1016	0	600792	600284.0	0.00000	1.00000	0.92848	1.85696

262	264.5	5	1329	1329	0	599776	599111.5	0.00000	1.00000	0.92848	4.64240
267	268.5	3	1531	1531	0	598447	597681.5	0.00000	1.00000	0.92848	2.78544
270	271.5	3	6043	6043	0	596916	593894.5	0.00000	1.00000	0.92848	2.78544
273	274.0	2	197	197	0	590873	590774.5	0.00000	1.00000	0.92848	1.85696
275	275.5	1	673	673	0	590676	590339.5	0.00000	1.00000	0.92848	0.92848
276	278.0	4	1755	1755	0	590003	589125.5	0.00000	1.00000	0.92848	3.71392
280	281.0	2	1206	1206	0	588248	587645.0	0.00000	1.00000	0.92848	1.85696
282	284.5	5	115	115	0	587042	586984.5	0.00000	1.00000	0.92848	4.64240
287	287.5	1	6654	6654	0	586927	583600.0	0.00000	1.00000	0.92848	0.92848
288	289.0	2	3309	3309	0	580273	578618.5	0.00000	1.00000	0.92848	1.85696
290	290.5	1	1939	1939	0	576964	575994.5	0.00000	1.00000	0.92848	0.92848
291	291.5	1	1773	1773	0	575025	574138.5	0.00000	1.00000	0.92848	0.92848
292	293.5	3	514	514	0	573252	572995.0	0.00000	1.00000	0.92848	2.78544
295	297.0	4	4061	4061	0	572738	570707.5	0.00000	1.00000	0.92848	3.71392
299	299.5	1	110	110	0	568677	568622.0	0.00000	1.00000	0.92848	0.92848
300	301.5	3	12888	12888	0	568567	562123.0	0.00000	1.00000	0.92848	2.78544
303	307.5	9	180	180	0	555679	555589.0	0.00000	1.00000	0.92848	8.35633
312	313.5	3	2064	2064	0	555499	554467.0	0.00000	1.00000	0.92848	2.78544
315	316.5	3	3217	3217	0	553435	551826.5	0.00000	1.00000	0.92848	2.78544
318	319.0	2	995	995	0	550218	549720.5	0.00000	1.00000	0.92848	1.85696
320	322.0	4	2778	2778	0	549223	547834.0	0.00000	1.00000	0.92848	3.71392
324	327.0	6	2451	2451	0	546445	545219.5	0.00000	1.00000	0.92848	5.57088
330	332.0	4	2959	2959	0	543994	542514.5	0.00000	1.00000	0.92848	3.71392
334	335.0	2	182	182	0	541035	540944.0	0.00000	1.00000	0.92848	1.85696
336	338.0	4	2203	2203	0	540853	539751.5	0.00000	1.00000	0.92848	3.71392
340	345.0	10	1832	1832	0	538650	537734.0	0.00000	1.00000	0.92848	9.28481
350	350.5	1	19020	19020	0	536818	527308.0	0.00000	1.00000	0.92848	0.92848
351	353.0	4	434	434	0	517798	517581.0	0.00000	1.00000	0.92848	3.71392
355	357.5	5	191	191	0	517364	517268.5	0.00000	1.00000	0.92848	4.64240
360	362.0	4	32955	32955	0	517173	500695.5	0.00000	1.00000	0.92848	3.71392
364	364.5	1	465	465	0	484218	483985.5	0.00000	1.00000	0.92848	0.92848
365	365.5	1	122353	122353	0	483753	422576.5	0.00000	1.00000	0.92848	0.92848
366	367.0	2	1191	1191	0	361400	360804.5	0.00000	1.00000	0.92848	1.85696
368	368.5	1	535	535	0	360209	359941.5	0.00000	1.00000	0.92848	0.92848
369	369.5	1	376	376	0	359674	359486.0	0.00000	1.00000	0.92848	0.92848
370	372.5	5	6429	6429	0	359298	356083.5	0.00000	1.00000	0.92848	4.64240
375	377.5	5	2425	2425	0	352869	351656.5	0.00000	1.00000	0.92848	4.64240

380	382.5	5	6174	6174	0	350444	347357.0	0.00000	1.00000	0.92848	4.64240
385	387.5	5	9805	9805	0	344270	339367.5	0.00000	1.00000	0.92848	4.64240
390	392.5	5	3652	3652	0	334465	332639.0	0.00000	1.00000	0.92848	4.64240
395	397.5	5	863	863	0	330813	330381.5	0.00000	1.00000	0.92848	4.64240
400	400.5	1	5370	5370	0	329950	327265.0	0.00000	1.00000	0.92848	0.92848
401	403.0	4	1969	1969	0	324580	323595.5	0.00000	1.00000	0.92848	3.71392
405	407.5	5	188	188	0	322611	322517.0	0.00000	1.00000	0.92848	4.64240
410	412.5	5	611	611	0	322423	322117.5	0.00000	1.00000	0.92848	4.64240
415	417.5	5	2205	2205	0	321812	320709.5	0.00000	1.00000	0.92848	4.64240
420	422.0	4	2619	2619	0	319607	318297.5	0.00000	1.00000	0.92848	3.71392
424	424.5	1	1361	1361	0	316988	316307.5	0.00000	1.00000	0.92848	0.92848
425	427.5	5	2070	2070	0	315627	314592.0	0.00000	1.00000	0.92848	4.64240
430	433.5	7	1449	1449	0	313557	312832.5	0.00000	1.00000	0.92848	6.49937
437	438.5	3	162	162	0	312108	312027.0	0.00000	1.00000	0.92848	2.78544
440	445.0	10	1477	1477	0	311946	311207.5	0.00000	1.00000	0.92848	9.28481
450	452.5	5	12979	12979	0	310469	303979.5	0.00000	1.00000	0.92848	4.64240
455	456.0	2	1098	1098	0	297490	296941.0	0.00000	1.00000	0.92848	1.85696
457	458.0	2	334	334	0	296392	296225.0	0.00000	1.00000	0.92848	1.85696
459	459.5	1	129	129	0	296058	295993.5	0.00000	1.00000	0.92848	0.92848
460	464.0	8	422	422	0	295929	295718.0	0.00000	1.00000	0.92848	7.42785
468	471.0	6	3203	3203	0	295507	293905.5	0.00000	1.00000	0.92848	5.57088
474	474.5	1	658	658	0	292304	291975.0	0.00000	1.00000	0.92848	0.92848
475	477.5	5	6429	6429	0	291646	288431.5	0.00000	1.00000	0.92848	4.64240
480	487.5	15	3247	3247	0	285217	283593.5	0.00000	1.00000	0.92848	13.92721
495	497.5	5	7302	7302	0	281970	278319.0	0.00000	1.00000	0.92848	4.64240
500	507.5	15	7094	7094	0	274668	271121.0	0.00000	1.00000	0.92848	13.92721
515	524.0	18	228	228	0	267574	267460.0	0.00000	1.00000	0.92848	16.71265
533	536.5	7	767	767	0	267346	266962.5	0.00000	1.00000	0.92848	6.49937
540	543.5	7	5396	5396	0	266579	263881.0	0.00000	1.00000	0.92848	6.49937
547	547.5	1	1966	1966	0	261183	260200.0	0.00000	1.00000	0.92848	0.92848
548	549.0	2	3704	3704	0	259217	257365.0	0.00000	1.00000	0.92848	1.85696
550	555.0	10	16695	16695	0	255513	247165.5	0.00000	1.00000	0.92848	9.28481
560	562.5	5	558	558	0	238818	238539.0	0.00000	1.00000	0.92848	4.64240
565	566.5	3	1383	1383	0	238260	237568.5	0.00000	1.00000	0.92848	2.78544
568	569.0	2	4563	4563	0	236877	234595.5	0.00000	1.00000	0.92848	1.85696
570	577.0	14	101	101	0	232314	232263.5	0.00000	1.00000	0.92848	12.99873
584	587.0	6	74	74	0	232213	232176.0	0.00000	1.00000	0.92848	5.57088

590	592.5	5	288	288	0	232139	231995.0	0.00000	1.00000	0.92848	4.64240
595	597.5	5	379	379	0	231851	231661.5	0.00000	1.00000	0.92848	4.64240
600	606.5	13	8367	8367	0	231472	227288.5	0.00000	1.00000	0.92848	12.07025
613	621.5	17	1472	1472	0	223105	222369.0	0.00000	1.00000	0.92848	15.78417
630	632.5	5	4040	4040	0	221633	219613.0	0.00000	1.00000	0.92848	4.64240
635	637.5	5	257	257	0	217593	217464.5	0.00000	1.00000	0.92848	4.64240
640	645.0	10	177	177	0	217336	217247.5	0.00000	1.00000	0.92848	9.28481
650	653.5	7	10549	10549	0	217159	211884.5	0.00000	1.00000	0.92848	6.49937
657	666.0	18	434	434	0	206610	206393.0	0.00000	1.00000	0.92848	16.71265
675	682.5	15	1478	1478	0	206176	205437.0	0.00000	1.00000	0.92848	13.92721
690	695.0	10	2062	2062	0	204698	203667.0	0.00000	1.00000	0.92848	9.28481
700	705.0	10	21007	21007	0	202636	192132.5	0.00000	1.00000	0.92848	9.28481
710	712.5	5	1517	1517	0	181629	180870.5	0.00000	1.00000	0.92848	4.64240
715	717.5	5	1553	1553	0	180112	179335.5	0.00000	1.00000	0.92848	4.64240
720	722.5	5	6656	6656	0	178559	175231.0	0.00000	1.00000	0.92848	4.64240
725	727.5	5	3806	3806	0	171903	170000.0	0.00000	1.00000	0.92848	4.64240
730	731.0	2	97688	97688	0	168097	119253.0	0.00000	1.00000	0.92848	1.85696
732	736.0	8	210	210	0	70409	70304.0	0.00000	1.00000	0.92848	7.42785
740	745.0	10	6372	6372	0	70199	67013.0	0.00000	1.00000	0.92848	9.28481
750	755.0	10	6939	6939	0	63827	60357.5	0.00000	1.00000	0.92848	9.28481
760	770.0	20	2928	2928	0	56888	55424.0	0.00000	1.00000	0.92848	18.56961
780	782.5	5	513	513	0	53960	53703.5	0.00000	1.00000	0.92848	4.64240
785	787.5	5	1007	1007	0	53447	52943.5	0.00000	1.00000	0.92848	4.64240
790	795.0	10	501	501	0	52440	52189.5	0.00000	1.00000	0.92848	9.28481
800	812.5	25	10140	10140	0	51939	46869.0	0.00000	1.00000	0.92848	23.21202
825	835.0	20	1326	1326	0	41799	41136.0	0.00000	1.00000	0.92848	18.56961
845	847.5	5	1223	1223	0	40473	39861.5	0.00000	1.00000	0.92848	4.64240
850	855.0	10	1674	1674	0	39250	38413.0	0.00000	1.00000	0.92848	9.28481
860	875.0	30	1928	1928	0	37576	36612.0	0.00000	1.00000	0.92848	27.85442
890	895.0	10	253	253	0	35648	35521.5	0.00000	1.00000	0.92848	9.28481
900	905.0	10	15377	15377	0	35395	27706.5	0.00000	1.00000	0.92848	9.28481
910	911.0	2	1224	1224	0	20018	19406.0	0.00000	1.00000	0.92848	1.85696
912	913.5	3	1858	1858	0	18794	17865.0	0.00000	1.00000	0.92848	2.78544
915	917.5	5	3798	3798	0	16936	15037.0	0.00000	1.00000	0.92848	4.64240
920	925.0	10	2315	2315	0	13138	11980.5	0.00000	1.00000	0.92848	9.28481
930	940.0	20	4775	4775	0	10823	8435.5	0.00000	1.00000	0.92848	18.56961
950	955.0	10	3851	3851	0	6048	4122.5	0.00000	1.00000	0.92848	9.28481

960	962.5	5	1641	1641	0	2197	1376.5	0.00000	1.00000	0.92848	4.64240
965	972.5	15	545	545	0	556	283.5	0.00000	1.00000	0.92848	13.92721
980			11	11	0	11	5.5	0.00000	1.00000	0.92848	0.00000
			1670125								910.59099

Source: Computed from unit level data of NSS, Round 60, 2004

Notes: Sample weight has been applied

When the duration is truncated at 15 days, 30 days, 180 days and 365 days, the average duration of illness (in days) have been estimated as 14.46, 28.43, 168.23, and 339.54 respectively.

Appendix 2.3: Computation of average duration of ailment from tetanus using life table method based on NSS data, Round 60, 2004

Duration (days)	Mid point	Width	Total observation	(Contd.) Censored 1+3	(ended) Complete 2+4	Number entering interval	Number exposed to risk	Conditional proportion ending	Conditional proportion continuing	Cumulative proportion continuing	
t	m	w	O	E	F	G	G - E/2 = H	F/H	1- F/H = P	$C_{i+1} = C_i*P$	C*w
0	1.5	3	0	0	0	27195	27195.0	0.00000	1.00000	1.00000	3.00000
3	4.0	2	6798	0	6798	27195	27195.0	0.24997	0.75003	1.00000	2.00000
5	7.5	5	538	269	269	20397	20262.5	0.01328	0.98672	0.75003	3.75014
10	11.0	2	269	269	0	19859	19724.5	0.00000	1.00000	0.74007	1.48014
12	13.5	3	4158	3212	946	19590	17984.0	0.05260	0.94740	0.74007	2.22021
15	27.5	25	10191	10191	0	15432	10336.5	0.00000	1.00000	0.70114	17.52852
40	47.5	15	1387	1387	0	5241	4547.5	0.00000	1.00000	0.70114	10.51711
55	60.0	10	414	414	0	3854	3647.0	0.00000	1.00000	0.70114	7.01141
65	82.5	35	660	660	0	3440	3110.0	0.00000	1.00000	0.70114	24.53993
100	110.0	20	1939	1939	0	2780	1810.5	0.00000	1.00000	0.70114	14.02282
120	150.0	60	161	161	0	841	760.5	0.00000	1.00000	0.70114	42.06846
180	195.0	30	0	0	0	680	680.0	0.00000	1.00000	0.70114	21.03423
210			680	680	0	680	340.0	0.00000	1.00000	0.70114	
			27195								149.17298

Source: Computed from unit level data of NSS, Round 60, 2004 Notes: Sample weight has been applied

When the duration is truncated at 15 days and 180 days, the average duration of illness (in days) have been estimated as 14.99 and 137.16 respectively.

Appendix 3.1: Disability Weights for Diseases and Conditions following Global Burden of Disease Study (GBDS)

Name of the disease (NSS)	Sequela	Disability Weight (DW) GBDS 1990	Comment related to GBD 1990	Sequela	Disability Weight (DW) GBDS 2010
Name of the disease (NSS)	Sequela	Disability Weight (DW) GBDS 1990	Comment related to GBD 1990	Sequela	Disability Weight (DW) GBDS 2010
1. Diarrhoea/ dysentery	Diarrhoeal diseases – episodes[1]	0.105 (0.086- 0.119)	DW varies with age	Mild Moderate Severe	0.061(0.036-0.093) 0.202(0.133-0.299) 0.281(0.184-0.399)
2. Gastritis/gastric/ peptic ulcer	Peptic ulcer[1]	Untreated 0.115 Treated 0.003	Proportion treated 0.65		
3. Worm infestation	Hookworm disease	0.000	High intensity infection	Intestinal nematode infections: symptomatic (Nematode= Round worm)[3]	0.030(0.016-0.048)
	Ascariasis (Round worm)	0.000	High intensity infection		
	Trichuriasis (Whip worm)	0.000	High intensity infection		
4. Amoebiosis			DW (1990) of diarrhoea was used[1]		
5. Hepatitis/jaundice	Hepatitis B- episodes[1]	0.211 (0.170-0.212)	DW varies with age		
	Hepatitis C- episodes[1]	0.211 (0.170-0.212)	DW varies with age		

6. Heart disease	Rheumatic heart disease - cases	Untreated 0.323 Treated 0.171		Acute myocardial infarction: days 1-2	0.422(0.284-0.566)
	Acute myocardial infraction[1]	Untreated 0.491 Treated 0.395		Acute myocardial infarction: days 3-28	0.056(0.035-0.082)
(Ischemic heart disease)	Angina pectoris[1]	Untreated 0.227 Treated 0.095	Proportion treated 0.20	Angina pectoris: mild : moderate	0.037(0.022-0.058) 0.066(0.043-0.095)
	Congestive heart failure[1]	Untreated 0.323 Treated 0.171		: severe	0.167(0.109-0.234)
	Inflammatory heart disease- all sequelae	Untreated 0.323 Treated 0.171		Cardiac conduction disorder Claudication Heart failure: mild : moderate :severe	0.145(0.097-0.205) 0.016(0.008-0.028) 0.037(0.021-0.058) 0.070(0.044-0.102) 0.186(0.128-0.261)
7. Hypertension	Hypertensive heart disease – cases	0.243 (0.201-0.300)			
	Lower respiratory infections: episodes[1]	0.280	DW of children and elderly		
	Lower respiratory infections: chronic	0.099			
8. Respiratory disease including ear/nose/throat ailment	Upper respiratory infections: episodes[1]	0.000		Ear pain	0.018(0.009-0.031)
	Upper respiratory infections:pharyngitis[1]	0.070			
	Otitis media: epoisodes[1]	0.023			
	Otitis media: deafness	0.229 (0.213-0.233)	DW varies with age		
9. Tuberculosis	Tuberculosis- cases[1]	0.271 (0.264-0.294)	DW varies with age	TB- without HIV TB- with HIV	0.331(0.222-0.450) 0.339(0.267-0.547)

10. Bronchial Asthma	Asthma: cases[1]	Untreated 0.099 Treated 0.059	Proportion treated 0.45	Asthma: controlled : partially controlled : uncontrolled	0.009(0.004-0.018) 0.021(0.015-0.045) 0.132(0.087-0.190)
11. Disorders of joints and bones	Rheumatoid arthritis-cases[1]	Untreated 0.233 Treated 0.174	Proportion treated 0.40		
	Osteoarthritis: hip[1]	Untreated 0.156 Treated 0.108			
	Osteoarthritis: knee[1]	Untreated 0.156 Treated 0.108			
12. Diseases of kidney/urinary system	<u>Nephritis & Nephrosis</u> (i)Acute glomerulonephritis (ii)End stage renal disease[1] (considered for diabetic nephropathy)	Treated 0.107 for 0-44 years & 0.096 for 45+ Untreated 0.082 for 0-14 years & 0.104 for 15+	Proportion treated 0.30	Chronic kidney disease (stage-IV)[3] End-stage renal disease: with kidney transplant End-stage renal disease: on dialysis Urinary incontinence	0.105(0.069-0.154) 0.027(0.015-0.043) 0.573(0.397-0.749) 0.142(0.094-0.204)
13. Prostatic disorders	Benign prostatic hypertrophy-symptomatic cases[1]	0.038		Benign prostatic hypertrophy: symptomatic	0.070(0.046-0.102)
14. Gynaecological disorders			Not clear if infertility is included	Infertility: primary Infertility: secondary	0.011(0.005-0.021) 0.006(0.002-0.013)

15. Neurological disorders	Epilepsy- cases[1]	Untreated 0.150 Treated 0.065	Proportion treated 0.20	Treated, seizure free Treated, recent seizure Untreated severe	0.072(0.047-0.106) 0.319(0.211-0.445) 0.420(0.279-0.572) 0.657(0.464-0.827)
	Parkinson's disease[1]	Untreated 0.406 Treated 0.332	Proportion treated 0.20	Mild Moderate Severe	0.011(0.005-0.021) 0.263(0.179-0.360) 0.549(0.383-0.711)
	Multiple sclerosis-cases	0.411 (0.410-0.437)	DW varies with age	Mild Moderate Severe	0.198(0.137-0.278) 0.445(0.303-0.593) 0.707(0.522-0.857)
	Migraine – cases[2]	0.029 (0.025-0.030)		Headache: migraine : tension type	0.433(0.287-0.593) 0.040(0.025-0.062)
	Alzheimer's disease and other dementias- cases	0.666 (0.627- 0.667)	DW varies with age	Dementia: mild : moderate : sever	0.082(0.055-0.117) 0.346(0.233-0.475) 0.438(0.299-0.584)
	Cerebrovascular disease: long term stroke survivors[1]	Untreated 0.301 Treated 0.332	Proportion treated 0.20	Stroke: long-term consequences, mild : moderate : long-term consequences, severe	0.021(0.011-0.037) 0.076(0.050-0.110) 0.539(0.363-0.705)
16. Psychiatric disorders	Unipolar Depressive Disorders: mild episode[2]	0.140	Proportion treated 0.10	Major depressive disorder: mild episode : moderate episode :severe episode	0.159(0.107-0.223) 0.406(0.276-0.551) 0.655(0.469-0.816)
	UDD: moderate episode[2]	0.350			
	Unipolar major depression: episode[1]	Untreated 0.302 Treated 0.600			
	Dysthymia	0.140			
	Bipolar affective disorder- cases	Untreated 0.583 Treated 0.383		Manic episode Residual state	0.480(0.323-0.642) 0.035(0.021-0.055)
	Schizophrenia- cases	0.528 (0.406-0.572)	DW varies with age and treatment	Acute state Residual state	0.756(0.571-0.894) 0.576(0.399-0.756)
	Alcohol use –Alcohol dependence syndrome	0.180		Mild Moderate Severe	0.259(0.176-0.359) 0.388(0.262-0.529) 0.549(0.384-0.708)

16. Psychiatric disorders	Drug use – Dysfunctional and harmful drug use	0.252	DW varies with age	Cannabis dependence Cocaine dependence Heroin dependence	0.329(0.223-0.455) 0.376(0.235-0.553) 0.641(0.459-0.803)
	Post-traumatic stress disorder	0.105	DW varies with age	Anxiety disorder[3] : mild : moderate : severe	0.030(0.017-0.048) 0.149(0.101-0.210) 0.523(0.365-0.684)
	Obsessive-compulsive disorder	Untreated 0.129 Treated 0.080			
	Panic disorder- cases[1]	Untreated 0.173 Treated 0.091	Proportion treated 0.05	Anorexia nervosa Bulimia nervosa Attention-deficit hyperactivity disorder Conduct disorder	0.223(0.150-0.310) 0.049(0.031-0.074) 0.236(0.154-0.337)
	Insomnia (primary) -cases	0.100			
17. Conjunctivitis		DW not given			
18. Glaucoma	Low vision[2]	0.247 (0.227-0.282)		Distance vision: mild impairment : moderate impairment : severe impairment : blindness Near vision: impairment	0.004(0.001-0.010) 0.033(0.020-0.052) 0.191(0.129-0.269) 0.195(0.132-0.272) 0.013(0.006-0.024)
	Blindness[2]	0.600			
19. Cataract	Low vision[2]	0.271 (0.234-0.280)			
	Blindness[1]	Untreated 0.600 Treated 0.488	Proportion treated 0.30		
20. Diseases of skin	Skin diseases – cases[2]	0.056			
21. Goitre	Goiter grades 1 & 2 Mild development disability Cretinoidism Cretinism	0.000 0.006 0.255 0.804		Iodine-deficiency goitre[3]	0.200(0.134-0.283)

22. Diabetes mellitus	Cases[1]	Untreated 0.012 Treated 0.033	Proportion treated 0.05		
	Diabetic foot[1]	Untreated 0.137 Treated 0.129	Proportion treated 0.20	Diabetic foot	0.023(0.012-0.039)
	Neuropathy[1]	Untreated 0.078 Treated 0.064	Proportion treated 0.20	Diabetic neuropathy	0.099(0.066-0.145)
	Retinopathy-blindness[1]	Untreated 0.600 Treated 0.488 (for aged 15+)	Varies with age, Proportion treated 0.30		
	Amputation	Untreated 0.155 Treated 0.068	Proportion treated 0.30		
23. Under-nutrition	Protein-energy malnutrition: wasting	0.053	Applicable for age 0-4 years	Kwashiorkor Severe wasting[3]	0.055(0.033-0.085) 0.127(0.081-0.183)
	: stunting	0.002	Applicable for age 0-4 years		
	: developmental disability	0.024			
24. Anaemia	Iron-deficiency anaemia: mild	0.000		Anaemia[3]: mild : moderate : severe	0.005(0.002-0.011) 0.058(0.038-0.086) 0.164(0.112-0.228)
	Iron-deficiency anaemia: moderate	0.011 (0.011-0.012)	DW varies with age		
	Iron-deficiency anaemia: severe	0.090 (0.087-0.093)	DW varies with age		
	Severe anaemia due to maternal haemorrhage	0.093 (0.087-0.093)	DW varies with age		
	Anaemia due to malaria	0.012 (0.012-0.013)	DW varies with age		

25.Sexually transmitted diseases	Syphilis: primary	0.015 (0.014-0.015)	DW varies with age		
	: secondary	0.048 (0.044-0.048)	DW varies with age		
	: tertiary - cardiovascular	0.196			
	: tertiary - neurologic	0.283			
	Chlamydia: cervicitis	0.049			
	: pelvic inflammatory disease	Untreated 0.420 Treated 0.169			
	: ectopic pregnancy	0.549	Applicable for age 5-59 years		
	: tubo-ovarian abscess	0.549	Applicable for age 5-59 years		
	: chronic pelvic pain	0.122			
	: infertility	0.180			
	: symptomatic urethritis	0.067		HIV: symptomatic, pre-AIDS	0.221(0.146-0.310)
	: epididymitis	0.167		HIV/AIDS: receiving antiretroviral treatment	0.053(0.034-0.079)
	Gonorrhoea: cervicitis	0.049		HIV/AIDS: not receiving antiretroviral treatment	0.547(0.382-0.715)
	: pelvic inflammatory disease	0.169			
	: ectopic pregnancy	0.549	Applicable for age 5-59 years		
	: tubo-ovarian abscess	0.549	Applicable for age 5-59 years		
	: chronic pelvic pain	0.122			
	: infertility	0.180			
	: symptomatic urethritis	0.067			
	: epididymitis	0.167			
	: stricture	0.151			
	HIV/AIDS: HIV cases	0.135 (0.123-0.136)	DW varies with age		
	AIDS cases	0.505			

26. Malaria	Malaria: episodes[1]	0.191 (0.172-0.211)	DW varies with age		
	: neurological sequelae	0.471 (0.443-0.471)	DW varies with age		
	: anemia	0.012 (0.012-0.013)	DW varies with age and treatment		
27. Eruptive		DW not given		Herpes zoster[3]	0.061(0.039-0.094)
28. Mumps		DW not given			
29. Diptheria	Diptheria: episodes[1]	0.231	DW varies with age		
	: neurological complications	0.078			
	: myocarditis[1]	0.323			
30. Whooping cough	Pertussis: episodes	0.129 (0.016-0.160)	DW varies with age and treatment, Proportion treated 0.20		
	: mental retardation	0.450 (0.402-0.484)			
31. Fever of unknown origin					
32. Tetanus	Tetanus: episodes[1]	0.633 (0.604-0.640)	DW varies with age		
33. Filariasis/ Elephantiasis	Lymphatic filariasis : hydrocele>15cm	0.073 (0.066-0.075)	DW varies with age	Lymphatic filariasis: symptomatic[3]	0.110(0.073-0.157)
	: Bancroftian lymphedema	0.106 (0.067-0.128)	DW varies with age		
	: Brugain lymphedema	0.116 (0.064-0.128)	DW varies with age		
34. Locomotor disability				Motor impairment : mild : moderate : severe	 0.012(0.005-0.022) 0.076(0.050-0.109) 0.377(0.251-0.518)

35. Visual disability (excluding cataract)	Vision disorder, age related and other: low vision[2]	0.263 (0.227-0.282)		Distance vision : mild impairment :moderate impairment : severe impairment : blindness Near vision impair-ment	0.004 0.033 0.191 0.195 0.013
	Vision disorder, age related and other: blindness[2]	0.600			
36. Speech disability				Speech problems[3]	0.054(0.034-0.081)
37. Hearing disability	Mild[2]	0.000		Hearing loss: Mild : moderate : severe : profound : complete : mild with ringing : complete with ringing	0.005 0.023 0.032 0.031 0.033 0.038 0.092
	Moderate, treated[2]	0.040			
	Moderate, untreated[2]	0.120			
	Severe, treated[2]	0.120			
	Severe, untreated[2]	0.333			
38. Diseases of mouth/teeth/gum	Dental caries- episodes[1]	0.081		Periodontitis Dental caries: symptomatic	0.008 0.012
	Peridontal disease – cases	0.001			
	Edentulism – cases	0.020		Severe tooth loss	0.072
39. Accidents/ Injuries/ Burns/ Fractures/ Poisoning	Fractured skull (Short term)	0.431	Long term DW varies with age and treatment	Very complex Sequela	
	Intracranial injuries (Short term)	0.359	Long term DW varies with age and treatment		
	Frecture: Face bones	0.223			
		0.266			

	: Vertebral column	0.199			
	: Rib or sternum	0.247			
	: Pelvis	0.153	DW varies with age		
	: Clavicle, scapula	0.180			
	: Ulna or radius	0.100			
	: Hand bones	0.372			
	: Femur (Short term)	0.272			
	: Femur (Short term)	0.271			
	: Patella, tibia or fibula	0.196			
	: Ankle : Foot bones	0.077			
	Injured spinal cord	0.725			
39. Accidents/ Injuries/ Burns/ Fractures/ Poisoning	Dislocation of shoulder, elbow or hip	0.074			
	Other dislocation	0.074			
	Sprains	0.064			
	Amputation: Thumb	0.165			
	: Finger	0.102			
	: Arm	Untreated 0.308 Treated 0.257			
	: Toe	0.102			
	: Foot	0.300			
	: Leg	0.300			

39. Accidents/ Injuries/ Burns/ Fractures/ Poisoning	Internal injuries	0.208			
	Open wound	0.108			
	Injury to eyes (Short term)	0.108	Long term DW varies with treatment		
	Crushing	0.218			
	Burns <20% (Short term)	Untreated: 0.186 Treated: 0.158			
	Burns <20% (Long term)	Untreated: 0.041 Treated: 0.011			
	Burns >20% and < 60% (Short term)	Untreated: 0.469 Treated: 0.441			
	Burns >20% and < 60% (Short term)	0.255			
	Burns >60% (Short term)	Untreated: 0.469 Treated: 0.441			
	Burns >60% (Long term)	0.255			
	Injured nerves	Untreated: 0.078 Treated: 0.064			
	Poisoning: ages 0-14 : ages 14+	0.611 0.608			

40.Cancer and other tumours	Mouth and oropharynx[1]	Untreated: 0.145 Treated: 0.090		**Cancer**: Cancer: diagnosis and primary therapy Cancer: metastatic Mastectomy Stoma Terminal phase: with medication Terminal phase: without medication	0.294(0.199-0.411) 0.484(0.330-0.643) 0.038(0.022-0.059) 0.086(0.055-0.131) 0.508(0.348-0.670) 0.519(0.356-0.683)
	Oesophagus	Untreated: 0.217 Treated: 0.217			
	Stomach[1]	Untreated: 0.217 Treated: 0.217			
	Colon and rectum[1]	Untreated: 0.217 Treated: 0.217			
	Liver[1]	Untreated: 0.239 Treated: 0.239			
	Pancreas[1]	Untreated: 0.301 Treated: 0.237			
	Trachea, bronchus, and lung[1]	Untreated: 0.146 Treated: 0.146			
	Melanoma and other skin[1]	Untreated: 0.045 Treated: 0.045			
	Breast[1]	Untreated: 0.069 Treated: 0.086			
	Cervix uteri[1]	Untreated: 0.066 Treated: 0.075			
	Corpus uteri[1] (DW of age group 45-59 years)	Untreated: 0.066 Treated: 0.096	Treated DW varies with age		
	Ovary[1] (DW of age group 45-59 years)	Untreated: 0.081 Treated:0.084	Treated DW varies with age		
	Prostate[1]	Untreated: 0.113 Treated: 0.134			
	Bladder[1] (DW of age group 60+)	Untreated: 0.085 Treated: 0.085	Treated DW varies with age		
	Lymphoma and multiple myeloma[1]	Untreated: 0.089 Treated: 0.057			
	Leukemia[1] (DW of age group 45+)	Untreated: 0.112 Treated: 0.097	DW varies with age and treatment		
	Cancers – Terminal[1]	Untreated: 0.809 Treated: 0.809			

				Diabetic neuropathy[3]	0.099(0.066-0.145)
				Motor plus cognitive impairments: severe[3]	0.425(0.286-0.587)
				musculoskeletal problems (generalised, moderate)[3]	0.292(0.197-0.410)

Source:

1. Murray C. J. L. and Lopez A. D., (Ed.). (1996). *The global burden of disease: A comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020* (pp. 412-418). Global Burden of Disease and Injury Series, Vol. 1, Harvard School of Public Health.
2. Mathers C. D., Lopez A. D. and Murray C. J. L. (2006). The burden of disease and mortality by condition: Data, methods and results for 2001. In Lopez A. D., Mathers C. D., Ezzati M., Jamison D. T. and Murray C. J. L. (Ed.), *Global burden of disease and risk factors* (pp. 45- 240).
3. Salomon J. A., Vos T., Hogan D. R., Gagnon M., Naghavi M., Mokdad A. et al. (2012). Common values in assessing health outcomes from disease and injury: disability weights measurement study for the global Burden of Disease Study 2010, *Lancet*, 380(9859), 2129-2143.

Appendix 3.2: Distribution of number of deaths of females by age groups: India, 2004

Age groups	Population in '000			ASDR per 1000[b]	Number of deaths ('000)
	2001[a]	2006[a]	2004		
0--4	58772	54329	56106	17.5	982
5--9	59074	57637	58212	1.5	87
10--14	56713	58637	57867	0.9	52
15-19	48924	56290	53344	1.7	91
20-24	43866	48406	46590	2.1	98
25-29	41124	43330	42448	2.0	85
30-34	37650	40621	39433	2.4	95
35-39	33043	37179	35525	2.3	82
40-44	27267	32563	30445	3.0	91
45-49	21974	26741	24834	4.8	119
50-54	17565	21338	19829	5.7	113
55-59	14739	16753	15947	10.9	174
60-64	13099	13718	13470	17.2	232
65-69	10471	11693	11204	25.5	286
70-74	8046	8795	8495	44.3	376
75-79	2476	6217	4721	62.4	295
80+	1651	2411	2107	135.1	285
Total	496454	536658	520576	6.8	3541

[a] Office of the Registrar General & Census Commissioner, India. (2006). Population Projections for India and States 2001-2026

[b] Registrar General, India (2006): Sample Registration System: Statistical Report 2004

Note: ASDR for population 80+ has been calculated by the researcher

Appendix 3.3: Average age at death for females aged 80+: India, 2004 when e^0= 65.0 years

Age groups	Population 2001[#]	ASDR[*]	Number of deaths (a)	Nax[*]	Avg age at death (b)	a*b = q
80-84	1925650	0.13817431	266075	2.405	82.41	21925936.32
85-89	815935	0.21388234	174514	2.223	87.22	15221633.78
90-94	491453	0.31045526	152574	1.997	92.00	14036378.48
95-99	269514	0.42704173	115094	1.731	96.73	11133118.62
100+	49325	0.56236902	27739	1.778	101.78	2823204.89
	3551876		735996			65140272.09

[#] Census of India, 2001; Table C-1

[*] UN Extended Model Life Tables for e^0=20 to 100 by 2.5 years increment

Note: Average age at death for female population aged 80+ = (∑q/∑a

= 65140272.09/735996

= 88.51 years

Appendix 4.1: Computation of life expectancies and ailment-free life expectancies in India (2004) – Male

x	$_nq_x$	l_x	$_nL_x$	e_x	$_n\pi_x$	$\{(1-(_n\pi_x/100)\} *_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.06186	100000	95177	63.5	8.3	87277	5797737	58.0	5.5	8.7
1	0.01643	93814	371353	66.7	4.6	354271	5710460	60.9	5.8	8.7
5	0.00693	92273	459769	63.8	2.6	447815	5356189	58.0	5.8	9.0
10	0.00494	91634	457040	59.2	2.0	447899	4908374	53.6	5.6	9.5
15	0.00718	91182	454364	54.5	2.2	444368	4460475	48.9	5.6	10.2
20	0.00975	90527	450528	49.9	2.0	441517	4016107	44.4	5.5	11.1
25	0.01247	89644	445529	45.3	2.3	435282	3574589	39.9	5.4	12.0
30	0.01548	88526	439336	40.9	3.0	426156	3139307	35.5	5.4	13.3
35	0.02035	87155	431460	36.5	4.0	414202	2713151	31.1	5.4	14.7
40	0.02202	85382	422472	32.2	5.0	401348	2298950	26.9	5.3	16.4
45	0.04110	83502	409512	27.8	6.7	382075	1897601	22.7	5.1	18.3
50	0.05312	80070	390210	23.9	8.6	356652	1515527	18.9	5.0	20.8
55	0.07834	75817	365073	20.1	10.9	325280	1158875	15.3	4.8	24.0
60	0.11900	69877	329713	16.6	21.4	259154	833595	11.9	4.7	28.1
65	0.18173	61562	280815	13.5	24.4	212296	574440	9.3	4.2	30.9
70	0.25012	50374	220854	10.9	30.0	154598	362144	7.2	3.7	34.0
75	0.34858	37775	155533	8.7	37.3	97519	207546	5.5	3.2	36.8
80	0.44015	24607	94949	7.0	35.8	60957	110027	4.5	2.5	36.1
85+		13776	77519	5.6	36.7	49070	49070	3.6	2.0	36.4

Note: e_x and its related components are taken from SRS Life Table, Male, India, 2002-06
$_n\pi_x$ is computed from the unit level data of NSS, Round 60, 2004

Appendix 4.2: Computation of life expectancies and ailment-free life expectancies in India (2004): Female

X	$_nq_x$	l_x	$_nL_x$	e_x	$_n\pi_x$	$\{(1-(_n\pi_x/100)\} *_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.06424	100000	95135	66.1	6.8	88666	5922255	59.2	6.9	10.4
1	0.02173	93576	369058	69.6	4.1	353927	5833590	62.3	7.3	10.4
5	0.00772	91543	455948	67.1	2.1	446373	5479663	59.9	7.2	10.8
10	0.00499	90836	453048	62.6	1.5	446252	5033290	55.4	7.2	11.5
15	0.00876	90383	450061	57.9	2.4	439260	4587038	50.8	7.1	12.3
20	0.01079	89591	445578	53.4	2.7	433547	4147778	46.3	7.1	13.3
25	0.01089	88624	440709	49.0	4.0	423081	3714231	41.9	7.1	14.5
30	0.01109	87659	435901	44.5	4.7	415414	3291150	37.5	7.0	15.6
35	0.01326	86687	430595	40.0	6.2	403898	2875736	33.2	6.8	17.1
40	0.01317	85537	425023	35.5	8.3	389746	2471838	28.9	6.6	18.6
45	0.02593	84411	416963	30.9	9.2	378602	2082092	24.7	6.2	20.2
50	0.03172	82222	404966	26.7	10.8	361230	1703490	20.7	6.0	22.4
55	0.05454	79614	388062	22.5	10.7	346539	1342260	16.9	5.6	25.1
60	0.08816	75272	360850	18.6	22.0	281463	995721	13.2	5.4	28.9
65	0.13758	68636	320851	15.1	25.3	239676	714258	10.4	4.7	31.1
70	0.21225	59193	265505	12.1	32.6	178950	474582	8.0	4.1	33.7
75	0.29044	46629	199454	9.7	34.2	131241	295632	6.3	3.4	34.6
80	0.39505	33086	132068	7.6	32.5	89146	164391	5.0	2.6	34.6
85+		20015	120779	6.0	37.7	75245	75245	3.8	2.2	37.3

Note: e_x and its related components are taken from SRS Life Table, Female, India, 2002-06
$_n\pi_x$ is computed from the unit level data of NSS, Round 60, 2004

Appendix 4.3: Computation of life expectancies and ailment-free life expectancies in India (2017-18) – Male

x	$_nq_x$	l_x	$_nL_x$	e_x	$_n\pi_x$	$\{(1-(_n\pi_x/100)\} *_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.03673	100000	96871	68.2	3.0	93965	6309627	63.1	5.1	7.5
1	0.00479	96327	384174	69.8	2.4	374954	6215662	64.5	5.3	7.6
5	0.00295	95866	478622	66.1	1.5	471443	5840708	60.9	5.2	7.8
10	0.00310	95583	477177	61.3	1.0	472405	5369266	56.2	5.1	8.4
15	0.00444	95287	475442	56.5	1.1	470212	4896860	51.4	5.1	9.0
20	0.00638	94864	472883	51.7	0.7	469573	4426648	46.7	5.0	9.7
25	0.00812	94259	469467	47.0	1.2	463833	3957075	42.0	5.0	10.7
30	0.01104	93494	465027	42.4	1.7	457122	3493242	37.4	5.0	11.9
35	0.01578	92461	458853	37.8	2.5	447382	3036120	32.8	5.0	13.1
40	0.02143	91002	450393	33.4	3.5	434629	2588739	28.4	5.0	14.8
45	0.03080	89052	438799	29.1	5.1	416420	2154110	24.2	4.9	16.9
50	0.04508	86310	422485	24.9	8.4	386996	1737689	20.1	4.8	19.1
55	0.07509	82418	397499	21.0	9.0	361724	1350693	16.4	4.6	22.0
60	0.10129	76229	362660	17.4	20.6	287952	988969	13.0	4.4	25.4
65	0.14853	68508	318182	14.1	21.5	249773	701017	10.2	3.9	27.4
70	0.21800	58333	260743	11.1	28.0	187735	451244	7.7	3.4	30.3
75	0.30705	45616	193673	8.5	30.7	134215	263509	5.8	2.7	32.0
80	0.46969	31610	119985	6.2	31.0	82790	129294	4.1	2.1	34.0
85+		16763	74646	4.5	37.7	46504	46504	2.8	1.7	38.4

Note: e_x and its related components are taken from SRS Life Table, Male, India, 2014-18
$_n\pi_x$ is computed from the unit level data of NSS, Round 75, 2017-18

Appendix 4.4: Computation of life expectancies and ailment-free life expectancies in India (2017-18) – Female

x	$_nq_x$	l_x	$_nL_x$	e_x	$_n\pi_x$	$\{(1-(_n\pi_x/100)\} *_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.03921	100000	96736	70.7	2.5	94318	6435057	64.4	6.3	9.0
1	0.00610	96079	382829	72.5	2.1	374790	6340739	66.0	6.5	9.0
5	0.00339	95494	476657	69.0	0.9	472367	5965949	62.5	6.5	9.5
10	0.00285	95169	475170	64.2	1.2	469468	5493582	57.7	6.5	10.1
15	0.00429	94899	473527	59.4	1.2	467845	5024114	52.9	6.5	10.9
20	0.00534	94491	471228	54.6	1.0	466516	4556270	48.2	6.4	11.7
25	0.00588	93987	468585	49.9	1.7	460619	4089754	43.5	6.4	12.8
30	0.00713	93434	465567	45.2	3.0	451600	3629135	38.8	6.4	14.1
35	0.00921	92768	461822	40.5	3.9	443811	3177535	34.3	6.2	15.4
40	0.01386	91914	456567	35.8	6.2	428260	2733724	29.7	6.1	16.9
45	0.01864	90640	449320	31.3	8.0	413374	2305464	25.4	5.9	18.7
50	0.03764	88951	437065	26.9	10.5	391173	1892090	21.3	5.6	20.9
55	0.05256	85603	417385	22.8	13.0	363125	1500916	17.5	5.3	23.1
60	0.07946	81103	390339	18.9	20.9	308758	1137792	14.0	4.9	25.8
65	0.12015	74659	352055	15.3	24.3	266506	829033	11.1	4.2	27.4
70	0.18323	65689	299552	12.1	25.2	224065	562528	8.6	3.5	29.2
75	0.26739	53653	233579	9.2	28.7	166542	338463	6.3	2.9	31.4
80	0.43148	39306	153802	6.6	29.8	107969	171921	4.4	2.2	33.7
85+		22346	105184	4.7	39.2	63952	63952	2.9	1.8	39.1

Note: e_x and its related components are taken from SRS Life Table, Female, India, 2014-18
$_n\pi_x$ is computed from the unit level data of NSS, Round 75, 2017-18

Appendix 4.5: Computation of life expectancies and ailment-free life expectancies in India (2004) – Rural

x	${}_nq_x$	l_x	${}_nL_x$	e_x	${}_n\pi_x$	$\{(1-({}_n\pi_x/100)\} * {}_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.06957	100000	94730	63.5	7.5	87625	5792870	57.9	5.6	8.8
1	0.02162	93043	367030	67.2	4.2	351615	5705245	61.3	5.8	8.7
5	0.00836	91032	453255	64.7	2.2	443283	5353630	58.8	5.9	9.1
10	0.00544	90270	450125	60.2	1.8	442023	4910347	54.4	5.8	9.6
15	0.00866	89780	447072	55.5	2.3	436789	4468324	49.8	5.7	10.3
20	0.01149	89002	442535	51.0	2.4	431914	4031535	45.3	5.7	11.2
25	0.01302	87979	437085	46.5	3.1	423535	3599621	40.9	5.6	12.0
30	0.01455	86834	431095	42.1	3.9	414282	3176085	36.6	5.5	13.1
35	0.01819	85571	424038	37.7	5.1	402412	2761803	32.3	5.4	14.4
40	0.01883	84015	416341	33.4	6.4	389695	2359391	28.1	5.3	15.9
45	0.03666	82433	405097	28.9	7.2	375930	1969696	23.9	5.0	17.2
50	0.04348	79411	388836	24.9	8.7	355007	1593766	20.1	4.8	19.3
55	0.07013	75958	367350	21.0	9.6	332084	1238759	16.3	4.7	22.3
60	0.10737	70631	335255	17.3	19.5	269880	906674	12.8	4.5	25.8
65	0.16361	63048	290565	14.1	22.5	225188	636794	10.1	4.0	28.4
70	0.23909	52733	232787	11.4	29.3	164580	411606	7.8	3.6	31.5
75	0.32568	40125	167687	9.1	32.0	114027	247026	6.2	2.9	32.3
80	0.41919	27057	106011	7.3	31.8	72300	132999	4.9	2.4	32.7
85+		15715	92670	5.9	34.5	60699	60699	3.9	2.0	34.5

Note: e_x and its related components are taken from SRS Life Table, Rural, India, 2002-06
${}_n\pi_x$ is computed from the unit level data of NSS, Round 60, 2004

Appendix 4.6: Computation of life expectancies and ailment-free life expectancies in India (2004) – Urban

x	$_nq_x$	l_x	$_nL_x$	e_x	$_n\pi_x$	$\{(1-(_n\pi_x/100)\} *_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.03945	100000	96670	68.9	7.6	89323	6063084	60.6	8.3	12.0
1	0.00966	96055	381931	70.7	4.9	363216	5973761	62.2	8.5	12.0
5	0.00369	95127	474756	67.4	2.8	461463	5610544	59.0	8.4	12.5
10	0.00339	94775	473073	62.6	1.7	465031	5149081	54.3	8.3	13.2
15	0.00583	94454	470975	57.8	2.2	460614	4684051	49.6	8.2	14.2
20	0.00713	93903	467890	53.1	2.3	457129	4223437	45.0	8.1	15.2
25	0.00842	93234	464264	48.5	3.3	448943	3766308	40.4	8.1	16.7
30	0.01025	92449	459969	43.9	3.9	442030	3317365	35.9	8.0	18.3
35	0.01366	91502	454480	39.3	5.0	431756	2875335	31.4	7.9	20.0
40	0.01524	90252	448024	34.8	6.9	417110	2443579	27.1	7.7	22.2
45	0.02847	88876	438514	30.3	9.6	396417	2026469	22.8	7.5	24.7
50	0.03810	86346	423955	26.1	12.3	371809	1630052	18.9	7.2	27.7
55	0.05841	83056	403956	22.1	14.5	345382	1258243	15.1	7.0	31.5
60	0.09274	78205	374043	18.3	29.0	265571	912861	11.7	6.6	36.2
65	0.14540	70952	330134	14.9	32.7	222180	647291	9.1	5.8	38.8
70	0.20529	60635	272973	11.9	37.7	170062	425110	7.0	4.9	41.1
75	0.29897	48188	205283	9.4	45.4	112085	255048	5.3	4.1	43.7
80	0.41049	33781	133616	7.3	40.8	79101	142964	4.2	3.1	42.0
85+		19914	112238	5.6	43.1	63863	63863	3.2	2.4	42.7

Note: e_x and its related components are taken from SRS Life Table, Urban, India, 2002-06
$_n\pi_x$ is computed from the unit level data of NSS, Round 60, 2004

Appendix 4.7: Computation of life expectancies and ailment-free life expectancies in India (2017-18) – Rural

x	${}_nq_x$	l_x	${}_nL_x$	e_x	${}_n\pi_x$	$\{(1-({}_n\pi_x/100)\} * {}_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.04272	100000	96434	68.0	2.7	93830	6329310	63.3	4.7	6.9
1	0.00641	95728	381392	70.0	2.0	373764	6235480	65.1	4.9	6.9
5	0.00344	95114	474751	66.4	1.2	469054	5861716	61.6	4.8	7.2
10	0.00329	94786	473151	61.7	1.1	467946	5392662	56.9	4.8	7.8
15	0.00474	94474	471310	56.9	1.1	466126	4924716	52.1	4.8	8.4
20	0.00628	94026	468718	52.1	0.8	464968	4458590	47.4	4.7	9.0
25	0.00802	93436	465381	47.4	1.3	459331	3993622	42.7	4.7	9.8
30	0.01030	92686	461153	42.8	2.2	451008	3534291	38.1	4.7	10.9
35	0.01401	91732	455622	38.2	3.0	441953	3083283	33.6	4.6	12.0
40	0.02025	90447	447899	33.7	4.2	429087	2641330	29.2	4.5	13.3
45	0.02744	88615	437401	29.4	5.6	412907	2212243	25.0	4.4	15.1
50	0.04705	86183	421513	25.1	8.2	386949	1799336	20.9	4.2	16.8
55	0.07056	82128	396903	21.2	9.2	360388	1412387	17.2	4.0	18.9
60	0.09862	76333	363671	17.6	18.1	297847	1051999	13.8	3.8	21.7
65	0.14153	68805	320744	14.3	19.6	257878	754153	11.0	3.3	23.4
70	0.21218	59068	264907	11.2	23.2	203449	496274	8.4	2.8	25.0
75	0.29455	46535	199227	8.5	23.7	152010	292826	6.3	2.2	26.0
80	0.47483	32828	124264	6.0	24.0	94441	140816	4.3	1.7	28.5
85+		17240	73147	4.2	36.6	46375	46375	2.7	1.5	36.0

Note: e_x and its related components are taken from SRS Life Table, Rural, India, 2014-18
${}_n\pi_x$ is computed from the unit level data of NSS, Round 75, 2017-18

Appendix 4.8: Computation of life expectancies and ailment-free life expectancies in India (2017-18) – Urban

x	$_nq_x$	l_x	$_nL_x$	e_x	$_n\pi_x$	$\{(1-(_n\pi_x/100)\} *_nL_x$	TH_x	e'_x	e_x - e'_x	$\frac{(e_x - e'_x)*100}{e_x}$
0	0.02512	100000	97776	72.6	3.0	94843	6457693	64.6	8.0	11.1
1	0.00264	97488	389330	73.5	2.9	378039	6362850	65.3	8.2	11.2
5	0.00250	97231	485549	69.7	1.4	478751	5984810	61.6	8.1	11.7
10	0.00225	96988	484397	64.9	1.1	479069	5506059	56.8	8.1	12.5
15	0.00339	96770	483084	60.0	1.2	477287	5026990	51.9	8.1	13.4
20	0.00489	96442	481071	55.2	1.0	476260	4549703	47.2	8.0	14.5
25	0.00514	95970	478658	50.5	1.7	470521	4073443	42.4	8.1	16.0
30	0.00713	95477	475778	45.7	2.7	462932	3602922	37.7	8.0	17.4
35	0.00995	94797	471748	41.0	3.8	453822	3139990	33.1	7.9	19.2
40	0.01341	93854	466302	36.4	6.1	437858	2686169	28.6	7.8	21.4
45	0.02036	92595	458592	31.9	8.5	419612	2248311	24.3	7.6	23.9
50	0.03221	90710	446779	27.5	12.2	392272	1828700	20.2	7.3	26.7
55	0.05153	87788	428347	23.3	14.8	364952	1436428	16.4	6.9	29.8
60	0.07501	83264	401648	19.4	26.2	296416	1071476	12.9	6.5	33.7
65	0.11980	77019	363264	15.8	29.8	255011	775060	10.1	5.7	36.3
70	0.17483	67792	310591	12.5	33.8	205611	520048	7.7	4.8	38.6
75	0.26948	55940	243065	9.7	41.3	142679	314437	5.6	4.1	42.1
80	0.39729	40865	163612	7.3	42.0	94895	171758	4.2	3.1	42.4
85+		24630	133443	5.4	42.4	76863	76863	3.1	2.3	42.2

Note: e_x and its related components are taken from SRS Life Table, Urban, India, 2014-18
$_n\pi_x$ is computed from the unit level data of NSS, Round 75, 2017-18

Appendix 4.9: Gender and rural-urban differences in proportion of years under poor health by age India: 2004 and 2017-18

Age	Percentage of years in poor health to total life expectancy							
	2004		2017-18		2004		2017-18	
	Male	Female	Male	Female	Rural	Urban	Rural	Urban
0	8.7	10.4	7.5	9.0	8.8	12.0	6.9	11.1
1	8.7	10.4	7.6	9.0	8.7	12.0	6.9	11.2
5	9.0	10.8	7.8	9.5	9.1	12.5	7.2	11.7
10	9.5	11.5	8.4	10.1	9.6	13.2	7.8	12.5
15	10.2	12.3	9.0	10.9	10.3	14.2	8.4	13.4
20	11.1	13.3	9.7	11.7	11.2	15.2	9.0	14.5
25	12.0	14.5	10.7	12.8	12.0	16.7	9.8	16.0
30	13.3	15.6	11.9	14.1	13.1	18.3	10.9	17.4
35	14.7	17.1	13.1	15.4	14.4	20.0	12.0	19.2
40	16.4	18.6	14.8	16.9	15.9	22.2	13.3	21.4
45	18.3	20.2	16.9	18.7	17.2	24.7	15.1	23.9
50	20.8	22.4	19.1	20.9	19.3	27.7	16.8	26.7
55	24.0	25.1	22.0	23.1	22.3	31.5	18.9	29.8
60	28.1	28.9	25.4	25.8	25.8	36.2	21.7	33.7
65	30.9	31.1	27.4	27.4	28.4	38.8	23.4	36.3
70	34.0	33.7	30.3	29.2	31.5	41.1	25.0	38.6
75	36.8	34.6	32.0	31.4	32.3	43.7	26.0	42.1
80	36.1	34.6	34.0	33.7	32.7	42.0	28.5	42.4
85+	36.4	37.3	38.4	39.1	34.5	42.7	36.0	42.2

Source: Appendices 4.1 to 4.8

Appendix 4.10: Male and female morbidity prevalence rates by age groups and broad ailment types: India, 2004

Age groups	Prevalence rate (%)		Ailment type							
			Communicable diseases (%)		Non-communicable diseases (%)		Accidents/ injuries (%)		Others (%)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-4	5.2	4.5	4.0	3.7	0.2	0.1	0.1	0.0	0.9	0.7
5-14	2.3	1.8	1.6	1.3	0.2	0.2	0.1	0.0	0.4	0.3
15-29	2.2	3.0	1.2	1.5	0.5	0.7	0.2	0.0	0.4	0.8
30-44	3.9	6.2	1.7	2.3	1.2	2.4	0.2	0.1	0.8	1.4
45-59	8.5	10.2	2.6	3.1	4.1	5.2	0.3	0.2	1.5	1.8
60-75	24.4	25.5	4.6	4.5	16.3	17.3	0.5	0.4	3.0	3.4
75 +	36.7	34.4	4.4	4.1	26.6	25.6	0.6	0.7	5.2	3.9
All ages	5.3	6.1	2.4	2.6	1.8	2.3	0.2	0.1	0.9	1.1

Source: Computed from unit level data of NSS, Round 60, 2004

Appendix 4.11: Male and female morbidity prevalence rates by age groups and broad ailment types: India, 2017-18

Age groups	Prevalence rate (%)		Ailment type							
			Communicable diseases (%)		Non-communicable diseases (%)		Accidents/ injuries (%)		Others (%)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-4	2.5	2.2	2.3	2.1	0.1	0.1	0.0	0.0	0.0	0.0
5-14	1.3	1.1	1.2	1.0	0.1	0.1	0.0	0.0	0.0	0.0
15-29	1.0	1.3	0.8	0.9	0.2	0.4	0.0	0.0	0.0	0.0
30-44	2.5	4.2	1.2	1.9	1.2	2.2	0.1	0.0	0.0	0.1
45-59	7.4	10.3	1.8	2.5	5.4	7.6	0.1	0.1	0.0	0.1
60-75	22.5	23.0	3.4	3.6	18.6	18.8	0.2	0.1	0.3	0.4
75 +	32.1	31.0	4.7	3.9	26.5	26.7	0.4	0.2	0.4	0.2
All ages	4.1	5.2	2.0	2.2	2.0	2.9	0.1	0.0	0.0	0.1

Source: Computed from unit level data of NSS, Round 75, 2017-18

Appendix 4.12: Rural and urban morbidity prevalence rates by age groups and broad ailment types: India, 2004

Age groups	Prevalence rate (%)		Ailment type							
			Communicable diseases (%)		Non-communicable diseases (%)		Accidents/ injuries (%)		Others (%)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
0-4	4.8	5.3	3.8	3.9	0.2	0.2	0.1	0.1	0.7	1.1
5-14	2.0	2.2	1.4	1.4	0.2	0.2	0.1	0.1	0.3	0.5
15-29	2.6	2.6	1.3	1.3	0.6	0.5	0.1	0.1	0.5	0.7
30-44	5.0	5.2	2.0	1.9	1.7	2.1	0.2	0.2	1.1	1.0
45-59	8.4	11.8	2.8	2.8	3.7	7.1	0.2	0.3	1.6	1.6
60-75	22.7	32.2	4.8	3.4	14.3	25.1	0.4	0.5	3.2	3.2
75 +	32.5	43.5	4.5	3.5	22.4	35.7	0.7	0.7	4.9	3.6
All ages	5.4	6.6	2.5	2.4	1.8	2.8	0.1	0.2	1.0	1.1

Source: Computed from unit level data of NSS, Round 60, 2004

Appendix 4.13: Rural and urban morbidity prevalence rates by age groups and broad ailment types: India, 2017-18

Age groups	Prevalence rate (%)		Ailment type							
			Communicable diseases (%)		Non-communicable diseases (%)		Accidents/ injuries (%)		Others (%)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
0-4	2.2	3.0	2.1	2.8	0.1	0.2	0.0	0.0	0.0	0.0
5-14	1.1	1.2	1.0	1.1	0.1	0.1	0.0	0.0	0.0	0.0
15-29	1.1	1.3	0.8	0.9	0.2	0.3	0.0	0.0	0.0	0.0
30-44	3.0	4.1	1.5	1.6	1.5	2.4	0.1	0.1	0.0	0.1
45-59	7.6	11.6	2.2	1.9	5.2	9.5	0.1	0.1	0.0	0.1
60-75	19.7	29.0	3.6	3.3	15.6	25.2	0.2	0.1	0.3	0.4
75 +	26.2	41.7	5.1	2.5	20.6	38.6	0.3	0.3	0.3	0.3
All ages	4.0	6.1	2.0	2.2	1.9	3.7	0.1	0.1	0.0	0.1

Source: Computed from unit level data of NSS, Round 75, 2017-18

Appendix 5.1: Computation of life expectancies and healthy life expectancies in India (2003) – Case 1

x	$_nq_x$	l_x	$_nL_x$	e_x *	$_n\pi_x$ **	$\{(1-(_n\pi_x/100)\}*_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
15	0.00802	90396	450268	55.9	5.9	423702	4083040	45.2	10.7	19.2
20	0.01055	89671	446067	51.4	8.2	409490	3659338	40.8	10.6	20.6
25	0.01208	88715	440997	46.9	8.0	405717	3249848	36.6	10.3	21.9
30	0.01356	87653	435375	42.4	10.6	389225	2844131	32.4	10.0	23.5
35	0.01706	86465	428765	38.0	12.8	373883	2454906	28.4	9.6	25.3
40	0.02123	84990	420641	33.6	15.0	357545	2081023	24.5	9.1	27.1
45	0.03031	83185	409980	29.3	18.8	332904	1723478	20.7	8.6	29.3
50	0.04407	80664	394997	25.1	22.7	305333	1390574	17.2	7.9	31.3
55	0.06970	77109	372951	21.1	24.8	280459	1085241	14.1	7.0	33.3
60	0.10476	71735	340953	17.5	29.2	241395	804782	11.2	6.3	35.9
65	0.16346	64220	295956	14.3	35.2	191779	563387	8.8	5.5	38.7
70	0.23039	53723	238342	11.5	35.3	154207	371608	6.9	4.6	39.9
75	0.32376	41346	173059	9.2	41.0	102105	217401	5.3	3.9	42.8
80	0.41219	27959	110156	7.5	40.5	65543	115296	4.1	3.4	45.0
85+	1.00000	16435	98521	6.0	49.5	49753	49753	3.0	3.0	49.5

Source: * e_x and its related components are taken from the SRS Life Table, Total population, India, 2001-05
** $_n\pi_x$ is computed from the unit level data of WHS-India, 2003

Note: In case 1, proportion of poor health is based on self-rated general health

Appendix 5.2: Computation of life expectancies and healthy life expectancies in India (2003) – Case 2

x	$_nq_x$	l_x	$_nL_x$	e_x*	$_n\pi_x$**	$\{(1-(_n\pi_x/100)\}*_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
15	0.00802	90396	450268	55.9	5.5	425503	4122129	45.6	10.3	18.4
20	0.01055	89671	446067	51.4	8.4	408597	3696625	41.2	10.2	19.8
25	0.01208	88715	440997	46.9	8.2	404835	3288028	37.1	9.8	21.0
30	0.01356	87653	435375	42.4	10.6	389225	2883193	32.9	9.5	22.4
35	0.01706	86465	428765	38.0	12.7	374312	2493968	28.8	9.2	24.1
40	0.02123	84990	420641	33.6	14.2	360910	2119656	24.9	8.7	25.8
45	0.03031	83185	409980	29.3	16.8	341103	1758746	21.1	8.2	27.8
50	0.04407	80664	394997	25.1	20.5	314023	1417642	17.6	7.5	30.0
55	0.06970	77109	372951	21.1	20.2	297615	1103620	14.3	6.8	32.2
60	0.10476	71735	340953	17.5	25.2	255033	806005	11.2	6.3	35.8
65	0.16346	64220	295956	14.3	35.8	190004	550972	8.6	5.7	40.0
70	0.23039	53723	238342	11.5	35.7	153254	360968	6.7	4.8	41.6
75	0.32376	41346	173059	9.2	45.4	94490	207714	5.0	4.2	45.4
80	0.41219	27959	110156	7.5	47.3	58052	113224	4.0	3.5	46.0
85+	1.00000	16435	98521	6.0	44.0	55172	55172	3.4	2.6	44.1

Source: * e_x and its related components are taken from the SRS Life Table, Total population, India, 2001-05
** $_n\pi_x$ is computed from the unit level data of WHS-India, 2003

Note: In case 2, proportion of poor health is based on activity limitation

Appendix 5.3: Computation of life expectancies and healthy life expectancies in India (2003) – Case 3

x	$_nq_x$	l_x	$_nL_x$	e_x *	$_n\pi_x$ **	$\{(1-(_n\pi_x/100)\}*_nL_x$	TH_x	e'_x	$e_x - e'_x$	$\frac{(e_x - e'_x)*100}{e_x}$
15	0.00802	90396	450268	55.9	11.2	399825	3902351	43.2	12.7	22.8
20	0.01055	89671	446067	51.4	13.3	386907	3502526	39.1	12.3	24.0
25	0.01208	88715	440997	46.9	14.0	379387	3115619	35.1	11.8	25.1
30	0.01356	87653	435375	42.4	15.3	368601	2736231	31.2	11.2	26.4
35	0.01706	86465	428765	38.0	18.5	349330	2367630	27.4	10.6	27.9
40	0.02123	84990	420641	33.6	19.7	337792	2018300	23.7	9.9	29.3
45	0.03031	83185	409980	29.3	22.6	317345	1680508	20.2	9.1	31.1
50	0.04407	80664	394997	25.1	25.6	293959	1363163	16.9	8.2	32.7
55	0.06970	77109	372951	21.1	25.5	277767	1069204	13.9	7.2	34.3
60	0.10476	71735	340953	17.5	30.0	238666	791437	11.0	6.5	37.0
65	0.16346	64220	295956	14.3	36.0	189396	552771	8.6	5.7	39.8
70	0.23039	53723	238342	11.5	38.5	146599	363375	6.8	4.7	41.2
75	0.32376	41346	173059	9.2	40.8	102515	216777	5.2	4.0	43.0
80	0.41219	27959	110156	7.5	44.3	61392	114262	4.1	3.4	45.5
85+	1.00000	16435	98521	6.0	46.3	52870	52870	3.2	2.8	46.4

Source: * e_x and its related components are taken from the SRS Life Table, Total population, India, 2001-05
** $_n\pi_x$ is computed from the unit level data of WHS-India, 2003

Note: In case 3, proportion of poor health is based on functional health involving social, psychological and physical domains of health

Appendix 5.4: Life expectancies and Healthy life expectancies among males in India, 2003

Age	e(x)	e'(x) Case 1	e'(x) Case 2	e'(x) Case 3
15	54.3	46.1	46.4	44.1
20	49.7	41.6	42.0	39.9
25	45.2	37.4	37.8	35.8
30	40.7	33.1	33.5	31.8
35	36.3	28.9	29.4	27.9
40	32.0	25.0	25.5	24.2
45	27.8	21.1	21.6	20.6
50	23.8	17.6	18.0	17.2
55	20.0	14.3	14.8	14.2
60	16.5	11.4	11.8	11.4
65	13.4	9.0	9.1	8.9
70	10.9	7.2	7.3	7.2
75	8.7	5.4	5.6	5.7
80	7.1	4.7	4.8	4.8
85+	5.7	3.7	4.5	4.1

Source: The computation of healthy life expectancy is based on the SRS Life Table, Male, India (2001-05) and the WHS-India, 2003
e(x) = Life expectancy at age x, e'(x) = healthy life expectancy at age x
Case 1: Based on self rating of general health
Case 2: Based on self-reported activity limitation
Case 3: Based on self-reported functional health involving social, psychological and physical domains of health

Appendix 5.5: Life expectancies and healthy life expectancies among females in India, 2003

Age	e(x)	e'(x) Case1	e'(x) Case 2	e'(x) Case 3
15	57.7	44.2	44.6	42.1
20	53.2	39.9	40.3	38.1
25	48.8	35.8	36.2	34.2
30	44.4	31.7	32.1	30.5
35	39.8	27.8	28.1	26.7
40	35.4	23.9	24.2	23.2
45	30.9	20.2	20.4	19.6
50	26.6	16.8	16.9	16.4
55	22.4	13.7	13.6	13.4
60	18.6	10.9	10.4	10.5
65	15.1	8.4	7.8	8.1
70	12.2	6.5	5.9	6.1
75	9.8	5.1	4.4	4.7
80	7.8	3.5	3.4	3.4
85+	6.2	2.6	2.6	2.7

Source: The computation of healthy life expectancy is based on the SRS Life Table, Female, India (2001-05) and the WHS-India, 2003
e(x) = Life expectancy at age x, e´(x) = healthy life expectancy at age x
Case 1, 2 and 3 as indicated in Appendix 5.4

Appendix 5.6: Life expectancies and Healthy life expectancies (following the OECD categorization) among males in India 2003

Age	e(x)	e'(x) Case 1	e'(x) Case 2	e'(x) Case 3
15	54.3	32.0	38.3	44.1
20	49.7	28.2	34.3	39.9
25	45.2	24.8	30.5	35.8
30	40.7	21.3	26.7	31.8
35	36.3	18.1	23.0	27.9
40	32.0	15.1	19.5	24.2
45	27.8	12.4	16.3	20.6
50	23.8	9.9	13.1	17.2
55	20.0	7.7	10.4	14.2
60	16.5	5.9	8.0	11.4
65	13.4	4.1	5.9	8.9
70	10.9	3.3	5.0	7.2
75	8.7	2.7	4.1	5.7
80	7.1	2.4	3.6	4.8
85+	5.7	1.1	3.4	4.1

Source: The computation of healthy life expectancy is based on SRS Life Table, Male, India (2001-05) and the WHS-India, 2003
e(x) = Life expectancy at age x, e'(x) = healthy life expectancy at age x
Case 1: Based on self rating of general health (Following OECD categorization)
Case 2: Based on self-reported activity limitation (Following OECD categorization)
Case 3: Based on self-reported functional health involving social, psychological and physical domains of health

Appendix 5.7: Life expectancies and healthy life expectancies (following the OECD categorization) among females in India, 2003

Age	e(x)	e'(x) Case1	e'(x) Case 2	e'(x) Case 3
15	57.7	28.1	35.4	42.1
20	53.2	24.3	31.3	38.1
25	48.8	21.1	27.6	34.2
30	44.4	18.0	24.1	30.5
35	39.8	15.1	20.6	26.7
40	35.4	12.3	17.5	23.2
45	30.9	9.9	14.4	19.6
50	26.6	8.0	11.6	16.4
55	22.4	6.1	9.2	13.4
60	18.6	4.3	6.7	10.5
65	15.1	3.1	5.0	8.1
70	12.2	2.2	3.6	6.1
75	9.8	1.9	2.5	4.7
80	7.8	1.0	1.9	3.4
85+	6.2	0.8	2.0	2.7

Source: The computation of healthy life expectancy is based on the SRS Life Table, Female, India (2001-05) and the WHS-India, 2003
e(x) = Life expectancy at age x, e´(x) = healthy life expectancy at age x
Case 1, 2 and 3 as indicated in Appendix 5.6

Appendix 5.8: Life expectancies and healthy life expectancies in rural and urban India, 2003

Age	e(x)		e'(x)	
	Rural	Urban	Rural	Urban
15	55.3	44.1	57.7	48.5
20	50.8	39.8	53.0	43.9
25	46.4	35.7	48.4	39.5
30	42.0	31.6	43.8	35.2
35	37.6	27.6	39.2	31.1
40	33.2	23.7	34.7	27.0
45	28.9	20.0	30.3	23.2
50	24.8	16.5	26.1	19.7
55	20.9	13.5	22.0	15.9
60	17.3	10.8	18.3	12.7
65	14.1	8.4	14.9	10.1
70	11.4	6.5	12.1	8.3
75	9.1	4.8	9.5	6.8
80	7.4	3.8	7.6	5.4
85+	6.0	2.6	5.9	4.7

Source: The computation of healthy life expectancy is based on the SRS Life Tables, Rural and Urban, India (2001-05) and the WHS-India, 2003
e(x) = Life expectancy at age x, e´(x) = healthy life expectancy at age x
Note: Healthy life expectancy is based on self-rated general health

Appendix 5.9: Healthy life expectancies in six states in India, 2003

x	Assam	Karnataka	Maharashtra	Rajasthan	Uttar Pradesh	West Bengal
15	46.4	53.9	47.4	42.7	42.7	41.2
20	42.2	49.3	42.9	38.5	38.4	36.8
25	38.1	44.8	38.5	34.3	34.4	33.0
30	33.8	40.4	34.2	30.2	30.4	29.1
35	29.5	35.9	29.9	26.2	26.8	25.1
40	25.4	31.6	25.8	22.4	23.1	21.5
45	21.3	27.4	21.8	19.1	19.5	18.1
50	17.6	23.5	18.5	15.9	16.0	14.7
55	14.3	20.1	15.2	12.8	13.1	11.8
60	11.1	17.1	12.5	10.3	10.1	8.8
65	8.1	14.2	10.2	8.4	7.7	6.9
70+	6.4	12.0	8.5	6.8	6.4	4.9

Source: The computation of healthy life expectancy is based on the SRS Life Tables of respective states of India (2001-05) and the WHS-India, 2003; Information on ASDR is also used from the SRS Statistical Report 2004, and population by single year age from the Census of India 2001, Table C-13

Appendix 5.10: Proportion of life in poor health in six states in India, 2003

x	Assam	Karnataka	Maharashtra	Rajasthan	Uttar Pradesh	West Bengal
15	9.6	5.9	18.0	26.1	21.7	27.7
20	10.3	6.4	19.4	27.4	23.2	29.6
25	10.8	6.8	20.9	29.3	24.8	30.8
30	12.0	7.4	22.6	31.4	26.6	32.6
35	13.2	8.3	24.7	33.7	27.6	34.8
40	14.6	9.3	27.1	35.8	29.5	36.5
45	16.6	10.5	29.9	37.6	31.7	38.4
50	18.5	11.3	31.6	39.4	34.6	41.5
55	20.3	11.4	33.9	41.9	36.3	43.7
60	24.4	10.0	35.1	43.8	40.4	49.0
65	29.6	9.9	35.9	47.0	44.6	50.6
70+	29.2	8.8	36.0	51.0	43.2	56.8

Source: The computation of healthy life expectancy is based on the SRS Life Tables of respective states of India (2001-05) and the WHS-India, 2003; Information on ASDR is also used from the SRS Statistical Report 2004, and population by single year age from the Census of India 2001, Table C-13

Appendix 6.1: Computation of life expectancies and healthy life expectancies of the poor in India

x	$_nm_x^*$	$_na_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x	$_n\pi_x^{**}$	$\{(1-(_n\pi_x/100)\}*_nL_x$	TH_x	e'_x	$e_x - e'_{x=}K$	$\frac{(K*100)}{e_x}$
0	0.05799	0.2	0.05542	100000	5542	366121	6336376	63.4						
1	0.00844	0.4	0.03309	94458	3126	399925	5970255	63.2						
5	0.00256	0.5	0.01272	91333	1162	453758	5570330	61.0						
10	0.00150	0.5	0.00747	90171	674	449170	5116571	56.7						
15	0.00234	0.5	0.01163	89497	1041	444883	4667401	52.2	9.8	401285	3630541	40.6	11.6	22.2
20	0.00343	0.5	0.01700	88456	1504	438520	4222518	47.7	11.4	388529	3229257	36.5	11.2	23.5
25	0.00318	0.5	0.01577	86952	1372	431331	3783998	43.5	11.2	383022	2840728	32.7	10.8	24.9
30	0.00376	0.5	0.01862	85580	1594	423917	3352667	39.2	14.3	363297	2457706	28.7	10.5	26.7
35	0.00490	0.5	0.02420	83986	2033	414850	2928750	34.9	16.2	347644	2094409	24.9	9.9	28.5
40	0.00667	0.5	0.03280	81954	2688	403047	2513900	30.7	21.7	315586	1746765	21.3	9.4	30.5
45	0.00882	0.5	0.04315	79265	3420	387776	2110853	26.6	19.2	313323	1431178	18.1	8.6	32.2
50	0.01338	0.5	0.06473	75845	4910	366951	1723076	22.7	30.0	256866	1117855	14.7	8.0	35.1
55	0.00985	0.5	0.04807	70935	3410	346153	1356125	19.1	25.5	257884	860989	12.1	7.0	36.5
60	0.03276	0.5	0.15140	67526	10223	312070	1009973	15.0	29.9	218761	603106	8.9	6.0	40.3
65	0.03044	0.5	0.14144	57302	8105	266250	697903	12.2	39.5	161081	384345	6.7	5.5	44.9
70	0.09662	0.5	0.38911	49198	19143	198130	431653	8.8	40.5	117887	223263	4.5	4.2	48.3
75	0.05770	0.5	0.25213	30054	7578	131328	233523	7.8	53.3	61330	105376	3.5	4.3	54.9
80	0.21994	0.5	1.00000	22477	22477	102195	102195	4.5	56.9	44046	44046	2.0	2.6	56.9

Source: $^*{}_nm_x$ is computed from the unit level data of NFHS-2, India, 1998-99
$^{**}{}_n\pi_x$ is computed from the unit level data of WHS-India, 2003

Note: $_nq_x = (n^* {}_nm_x)/ [1+ (n- {}_na_x)^* {}_nm_x]$; $l_{x+n} = l_x (1- {}_nq_x)$; $_nd_x = l_x{}^* {}_nq_x$

$_nL_x = n^* l_{x+n} + {}_na_x * {}_nd_x$; $_\infty L_x = l_x / {}_\infty m_x$; $T_x = T_{x+n} / {}_nL_x$; $e_x = T_x / l_x$

Appendix 6.2: Computation of life expectancies and healthy life expectancies of the non-poor in India

x	${}_nm_x{}^*$	${}_na_x$	${}_nq_x$	l_x	${}_nD_x$	${}_nL_x$	T_x	e_x	${}_n\pi_x{}^{**}$	$\{(1-({}_n\pi_x/100)\}*{}_nL_x$	TH_x	e'_x	$e_x - e'_x = K$	$\frac{(K*100)}{e_x}$
0	0.03847	0.2	0.03732	100000	3732	97388	6815247	68.2						
1	0.00348	0.4	0.01380	96268	1329	412101	6717860	69.8						
5	0.00119	0.5	0.00593	94939	563	473287	6305759	66.4						
10	0.00095	0.5	0.00474	94376	447	470760	5832472	61.8						
15	0.00148	0.5	0.00737	93928	693	467911	5361712	57.1	3.9	449663	4432572	47.2	9.9	17.3
20	0.00195	0.5	0.00970	93236	905	463918	4893800	52.5	6.8	432372	3982909	42.7	9.8	18.6
25	0.00199	0.5	0.00990	92331	914	459371	4429882	48.0	6.2	430890	3550537	38.5	9.5	19.9
30	0.00231	0.5	0.01148	91417	1050	454461	3970511	43.4	8.7	414923	3119647	34.1	9.3	21.4
35	0.00254	0.5	0.01262	90367	1140	448986	3516050	38.9	10.6	401393	2704724	29.9	9.0	23.1
40	0.00362	0.5	0.01794	89227	1601	442133	3067064	34.4	11.4	391730	2303331	25.8	8.6	24.9
45	0.00535	0.5	0.02640	87626	2313	432349	2624930	30.0	18.6	351932	1911600	21.8	8.1	27.2
50	0.00812	0.5	0.03979	85313	3395	418080	2192581	25.7	18.9	339063	1559668	18.3	7.4	28.9
55	0.00864	0.5	0.04229	81919	3464	400933	1774501	21.7	24.4	303105	1220605	14.9	6.8	31.2
60	0.02093	0.5	0.09945	78454	7802	372767	1373568	17.5	28.8	265410	917500	11.7	5.8	33.2
65	0.02374	0.5	0.11205	70652	7917	333471	1000801	14.2	33.6	221425	652090	9.2	4.9	34.8
70	0.06130	0.5	0.26577	62736	16673	271996	667330	10.6	33.1	181965	430665	6.9	3.8	35.5
75	0.05074	0.5	0.22514	46063	10371	204386	395334	8.6	34.0	134895	248700	5.4	3.2	37.1
80	0.18692	0.5	1.00000	35692	35692	190948	190948	5.3	40.4	113805	113805	3.2	2.2	40.4

Source: ${}^*{}_nm_x$ is computed from the unit level data of NFHS-2, India, 1998-99
${}^{**}{}_n\pi_x$ is computed from the unit level data of WHS-India, 2003

Note: ${}_nq_x = (n^* {}_nm_x)/ [1+ (n- {}_na_x)^* {}_nm_x]$; $l_{x+n} = l_x (1- {}_nq_x)$; ${}_nd_x = l_x{}^* {}_nq_x$
${}_nL_x = n^* l_{x+n} + {}_na_x * {}_nd_x$; ${}_\infty L_x = l_x/ {}_\infty m_x$; $T_x = T_{x+n}/ {}_nL_x$; $e_x = T_x/ l_x$

Appendix 6.3: Computation of life expectancies and healthy life expectancies of the Hindus in India

x	$_nm_x{}^*$	$_na_x$	$_nq_x$	l_x	$_nD_x$	$_nL_x$	T_x	e_x	$_n\pi_x{}^{**}$	$\{(1-(_n\pi_x/100)\}*_nL_x$	TH_x	e'_x	$e_x - e'_{x}=K$	$\frac{(K*100)}{e_x}$
0	0.04701	0.2	0.04531	100000	4531	96829	6549866	65.5						
1	0.00509	0.4	0.02011	95469	1920	407289	6453037	67.6						
5	0.00161	0.5	0.00802	93549	750	465870	6045748	64.6						
10	0.00106	0.5	0.00529	92799	491	462769	5579878	60.1						
15	0.00174	0.5	0.00866	92309	800	459543	5117109	55.4	5.2	435647	4207372	45.6	9.9	17.8
20	0.00232	0.5	0.01153	91509	1055	454906	4657565	50.9	6.6	424882	3771725	41.2	9.7	19.0
25	0.00231	0.5	0.01148	90454	1039	449671	4202659	46.5	6.9	418643	3346843	37.0	9.5	20.4
30	0.00281	0.5	0.01395	89415	1248	443955	3752989	42.0	9.2	403111	2928199	32.7	9.2	22.0
35	0.00332	0.5	0.01646	88167	1452	437207	3309034	37.5	10.9	389552	2525088	28.6	8.9	23.7
40	0.00407	0.5	0.02015	86716	1747	429211	2871826	33.1	13.0	373414	2135536	24.6	8.5	25.6
45	0.00640	0.5	0.03150	84969	2676	418154	2442615	28.7	17.7	344141	1762122	20.7	8.0	27.9
50	0.00918	0.5	0.04487	82293	3692	402232	2024461	24.6	21.2	316959	1417982	17.2	7.4	30.0
55	0.00912	0.5	0.04458	78600	3504	384240	1622229	20.6	22.5	297786	1101023	14.0	6.6	32.1
60	0.02402	0.5	0.11330	75096	8508	354209	1237989	16.5	28.7	252551	803237	10.7	5.8	35.1
65	0.02619	0.5	0.12290	66588	8184	312479	883779	13.3	33.1	209049	550686	8.3	5.0	37.7
70+	0.10223	0.5	1.00000	58404	58404	571300	571300	9.8	40.2	341637	341637	5.8	3.9	40.2

Source: $^*{}_nm_x$ is computed from the unit level data of NFHS-2, India, 1998-99
$^{**}{}_n\pi_x$ is computed from the unit level data of WHS-India, 2003

Note: $_nq_x = (n^*{}_nm_x)/[1+(n-{}_na_x)^*{}_nm_x]$; $l_{x+n} = l_x(1-{}_nq_x)$; $_nd_x = l_x{}^*{}_nq_x$

$_nL_x = n^*\, l_{x+n} + {}_na_x * {}_nd_x$; $_\infty L_x = l_x/{}_\infty m_x$; $T_x = T_{x+n}/{}_nL_x$; $e_x = T_x/l_x$

Appendix 6.4: Computation of life expectancies and healthy life expectancies of the non-Hindus in India

x	${}_nm_x{}^*$	${}_na_x$	${}_nq_x$	l_x	${}_nD_x$	${}_nL_x$	T_x	e_x	${}_n\pi_x{}^{**}$	$\{(1-({}_n\pi_x/100)\}*{}_nL_x$	TH_x	e'_x	$e_x - e'_x = K$	$\frac{(K*100)}{e_x}$
0	0.03849	0.2	0.03734	100000	3734	97386	6756202	67.6						
1	0.00509	0.4	0.01999	96266	1925	410436	6658816	69.2						
5	0.00166	0.5	0.00827	94341	780	469757	6248379	66.2						
10	0.00120	0.5	0.00598	93561	560	466408	5778622	61.8						
15	0.00151	0.5	0.00752	93002	700	463260	5312214	57.1	8.6	423420	4044936	43.5	13.6	23.9
20	0.00215	0.5	0.01069	92302	987	459044	4848954	52.5	14.0	394778	3621517	39.2	13.3	25.3
25	0.00232	0.5	0.01153	91315	1053	453944	4389910	48.1	12.6	396747	3226739	35.3	12.7	26.5
30	0.00228	0.5	0.01134	90262	1023	448753	3935966	43.6	16.6	374260	2829992	31.4	12.3	28.1
35	0.00274	0.5	0.01361	89239	1214	443159	3487214	39.1	21.7	346994	2455732	27.5	11.6	29.6
40	0.00525	0.5	0.02591	88025	2281	434422	3044054	34.6	23.2	333636	2108738	24.0	10.6	30.7
45	0.00529	0.5	0.02610	85744	2238	423124	2609632	30.4	23.0	325806	1775102	20.7	9.7	32.0
50	0.00993	0.5	0.04845	83506	4046	407414	2186508	26.2	29.8	286005	1449296	17.4	8.8	33.7
55	0.00835	0.5	0.04090	79460	3250	389176	1779093	22.4	35.8	249851	1163291	14.6	7.7	34.6
60	0.02360	0.5	0.11143	76210	8492	359823	1389917	18.2	31.3	247198	913440	12.0	6.3	34.3
65	0.02311	0.5	0.10924	67719	7397	320099	1030094	15.2	43.8	179896	666242	9.8	5.4	35.3
70+	0.08496	0.5	1.00000	60321	60321	709995	709995	11.8	31.5	486346	486346	8.1	3.7	31.5

Source: ${}^*{}_nm_x$ is computed from the unit level data of NFHS-2, India, 1998-99
${}^{**}{}_n\pi_x$ is computed from the unit level data of WHS-India, 2003

Note: ${}_nq_x = (n^*{}_nm_x)/[1+(n-{}_na_x)^*{}_nm_x]$; $l_{x+n} = l_x(1-{}_nq_x)$; ${}_nd_x = l_x{}^*{}_nq_x$

${}_nL_x = n^* l_{x+n} + {}_na_x * {}_nd_x$; ${}_\infty L_x = l_x / {}_\infty m_x$; $T_x = T_{x+n} / {}_nL_x$; $e_x = T_x / l_x$